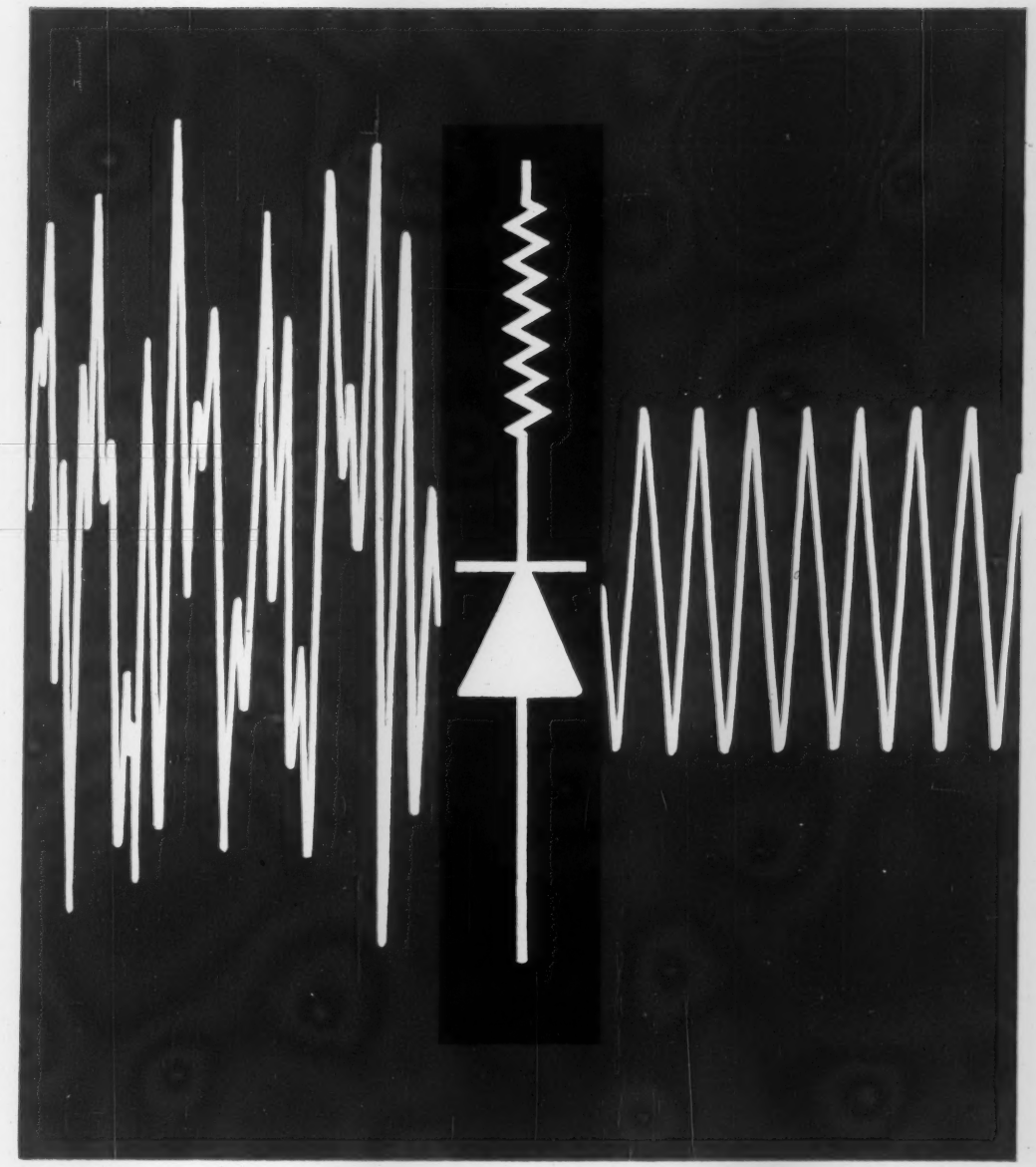
INSTRUMENTS AND CONTROL SYSTEMS

DECEMBER 1961 JOURNAL OF THE SCMA • PRECISION MEASUREMENTS ASSOCIATION • SIMULATION COUNCIL NEWSLETTER



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Emergency Power Systems 2246
Reluctive Transducers 2261
Mass Spectrometry in Science and Industry 2271

YOUR **FISHER/MAN** STANDS BEHIND THIS PNEUMATICALLY OPERATED PISTON...

FOR Inherent Accuracy– Power–Speed and Stability

FISHER TYPE 470 P.O.P.

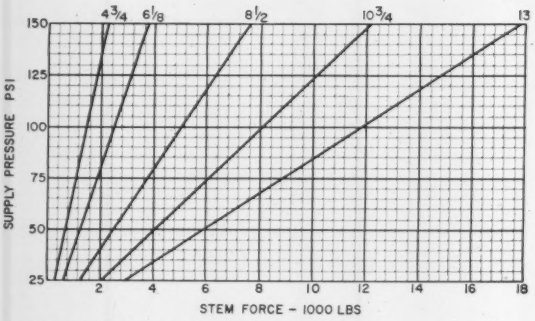
- **Delivers same power in either direction at any point of the stroke.**
- **Adaptable to virtually all types of valve bodies including Butterfly valves.**
- **No air set required—utilizes clean, non-corrosive air or gas up to 150 psi.**
- **Easily reversible actuator can be changed in the field.**

This small, compact piston actuator incorporates its own positioner mounted integrally on top of the cylinder. Positioner receives any of the normally used pneumatic instrument signals. Then, without an air set, actuator utilizes the full potential of the available instrument or gas supply to provide exceptional speed and power. Series 470 is available in six basic sizes and can be supplied for travel up to 4". Basic actuator can also be furnished with a handjack, hydraulic snubber, pneumatic safety devices or as a spring return unit. Write for Bulletin E-470.

Type 470 mounted on Design "A" body

PERFORMANCE DATA

Air Consumption (Static)	20 SCFH at 100 psi supply.
Instrument Signals	3 to 15 psi, 5 to 25 psi, 6 to 30 psi, 12 to 60 psi. Suitable for split range also.
Temperature Limitation	175°F.
Maximum Hysteresis	0.15% of total stroke or instrument signal.
Repeatability	0.03% of the total stroke or instrument signal.
Resolution Sensitivity	Minimum change in the measured variable to produce an effective movement of the final control element is .02% of the instrument pressure range.
Frequency Response	1.4 cps for the Size 60. 4 cps for the Size 30.
Load Sensitivity	Percent of total travel per 100 lbs. stem force is .065% for Size 60.



CYLINDER DIAMETERS AS MARKED ON EACH CURVE.

AVAILABLE STEM FORCE

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIPMENT COMPANY, CORAOPOLIS, PA.

FISHER® Controls

SINCE 1880

CIRCLE 1 ON READER-SERVICE CARD

LEWIS

Portable

MODEL 73PO

PYROMETER POTENTIOMETER

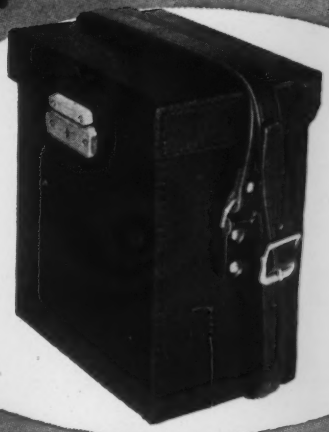
FOR MEASURING TEMPERATURES *Electrically*

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

AND FOR MOST INDUSTRIAL APPLICATIONS

Choose from 30 standard scale ranges.

Hand drawn Scales, eight inches long for easy readability.
Aluminum Case 5⅜" x 7¾" x 3¾";
Weight only 4 pounds 10 ounces.



Calibrated for use with Type J, Y, K or T thermocouples. Operated by two small flashlight cells, the 73PO contains no standard cell to freeze, can be used in temperatures as low as minus 20°F.

Electrical cold junction compensation insures accuracy from —20° to +120°F. ambient temperatures.

You CAN take it with you in a convenient leather carrying case, available at extra cost.

THE LEWIS ENGINEERING CO.
Specialists in Electrical Temperature Measurements
NAUGATUCK, CONNECTICUT

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***A new slant** on making high accuracy DC measurements conveniently and economically!*

The model PC
PocketPot*

(PHOTO ACTUAL SIZE)

SENSITIVE RESEARCH'S NEW MINIATURE DC POTENTIOMETER!

The Model PC "PocketPot," is a stable, completely self contained, high accuracy DC potentiometer, with internal galvanometer, reference standard source, and direct "in line" readout. It is ideally suited for use as an infinite impedance calibrator or measuring instrument. Additional voltage and current ranges can be obtained by using it in combination with the Model PC-S, a switch controlled, .05% accurate "plug in" unit of the same size. Both models, when used together, may be easily held and operated in the palm of the hand!*

PocketPot*

SPECIFICATIONS

ACCURACY: ± .05% of reading or ± .5 mv., whichever is greater.

RANGES: 0-5. 100 v. When used with PC-S 0—500 v. and 0—1 amp.

SENSITIVITY: Infinite resistance at null. When used with PC-S, 2,000 Ω/v.

RESOLUTION: Continuous, 1 mv. divisions on slide wire.

BATTERY OPERATED: Does not require an external power source.

READOUT: Direct "in line."

SIZE: 9" x 4¼" x 1¾". **WT:** 3 lbs.

PRICE: Model PC, $450.00; Model PC-S $175.00. F.O.B., New Rochelle, N.Y.

PocketPot*

Write for additional information or contact your nearest SRIC sales representative.

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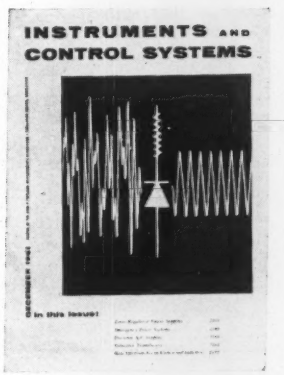
INSTRUMENT CORPORATION
NEW ROCHELLE, N. Y.

Symbol of Quality

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

CIRCLE 3 ON READER-SERVICE CARD

INSTRUMENTS AND CONTROL SYSTEMS



Regulation of fluctuating ac symbolizes this month's emphasis on power supplies

VOLUME 34, NUMBER 12, DECEMBER 1961

PRINT ORDER THIS MONTH 45,300

EDITORIAL

Season's Greetings 2237

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Precision A-C Supplies 2238
JAY MONROE—Survey of supplies useful in calibrating working-level a-c meters. This is the month's selection of the Precision Measurements Association.

Zener-Regulated Power Supplies 2242
JAY T. NICHOLS—Use of Zener diodes with shunt and bridge circuits provides supplies with high stability.

Emergency Power Systems 2246
THEODORE J. BRYDA—Motor/generator sets run continuously to avoid start-up interruption should power fail.

Line Voltage and Current Regulation 2248
AL RING—Simple sensing coil varies series rheostat.

Ultra-Isolation Transformers 2250
ROBERT C. McLOUGHLIN—Special shielding is required to prevent noise from jumping across transformers.

Process Control Systems 2254
Automatic liming of raw sugar juice.

Supplies for Digital Equipment 2256
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Reluctive Transducers 2261
HARRY N. NORTON—Review of reluctive transducers.

Binary-to-Gray Code Conversion 2267
GILBERT D. BEINHOCKER—Serial binary-to-Gray code conversion with a half adder and delay.

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INSTRUMENTS AND CONTROL SYSTEMS

VOL. 34 NO. 12

DECEMBER 1961

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Mass Spectrometry in Science and Industry 2272

DAVID J. FRAADE, ROYCE F. HOWARD—Uses of the sensitive mass spectrometer analyzer.

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BOILER COMBUSTION CONTROL SYSTEMS by J. W. Roth—Series, parallel, and combination control of fuel and air by load; also control element characterization.

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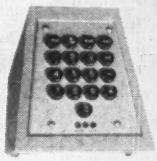
New Digital Data Reader for fastest scaling and viewing of oscillograms, maps and charts



–only $4975

This dependable, compact, low-priced reader reduces to digital information thousands of points of data per day and feeds them directly to typewriters or IBM keypunches. Output to punched paper tape is also available at a slight additional cost.

As shown above, Gerber's new Digital System comprises an X-Y reading head, S-2 Scanner and keyboard. All components and circuitry with the exception of the power supply are built into the reading head.

The standard one-axis system is designed so that the encoder may be switched instantly to either the X or Y axis at will. A two-encoder model for simultaneous reading of both axes is optional.

Zero reference can be located at any point on the graph. Multiple channels can be handled, each with a different scale factor and zero reference.

Standard Features

Lampbank display (Nixie) for channel count, coordinate values and time index counter.

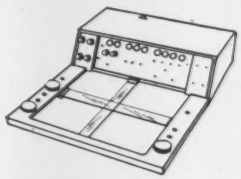
Patchboard programming permits patching in any desired output format of fixed digits, channel count, signs, coordinate values and time index count.

Time index counter range: 0-9999 (can be pre-set and cleared.)

Encoder digital range: 0-999 plus manual fourth digit.

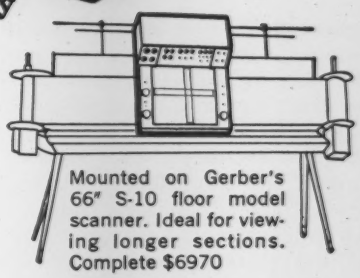
Send today for complete details.

Compare the versatility of Gerber's new "single unit" reader

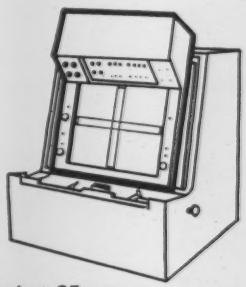


Reading head alone to take X-Y coordinates directly from maps and drawings. $4475

Mounted on Gerber's 16″ S-2 Scanner to reduce oscillograms and strip charts. Complete $4975



Mounted on Gerber's 66″ S-10 floor model scanner. Ideal for viewing longer sections. Complete $6970



Mounted on 35 mm film projector for records on roll film. $6875

Whether it's reducing large or small quantities of data, the new Gerber reader is the most economical and versatile model on the market today.

GSI

THE GERBER SCIENTIFIC INSTRUMENT CO.

P.O. Box 350, Hartford, Conn. • BU 9-2731

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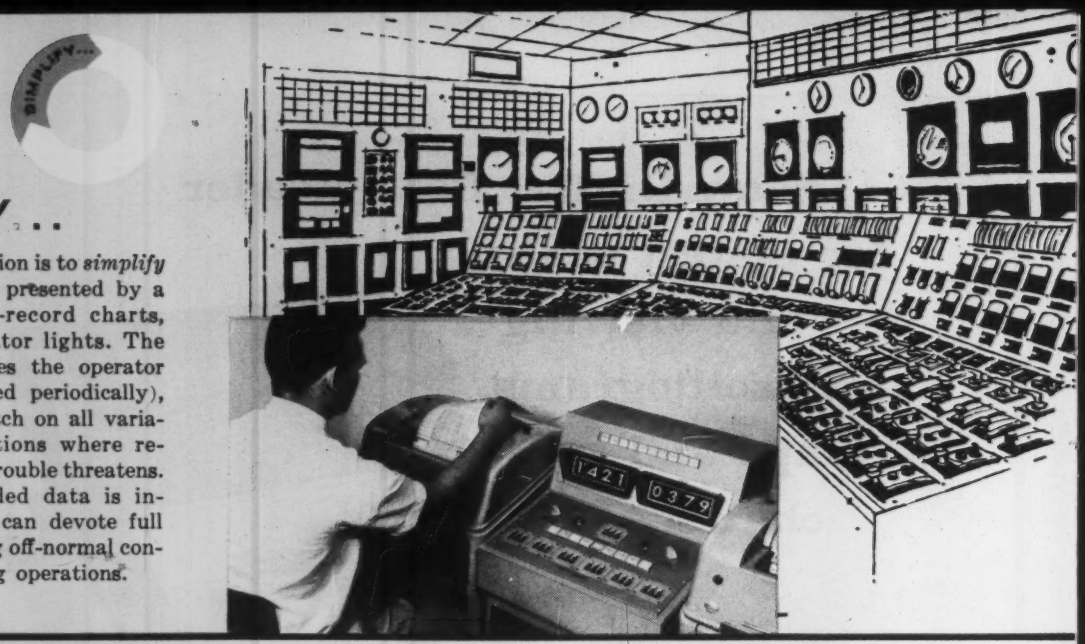
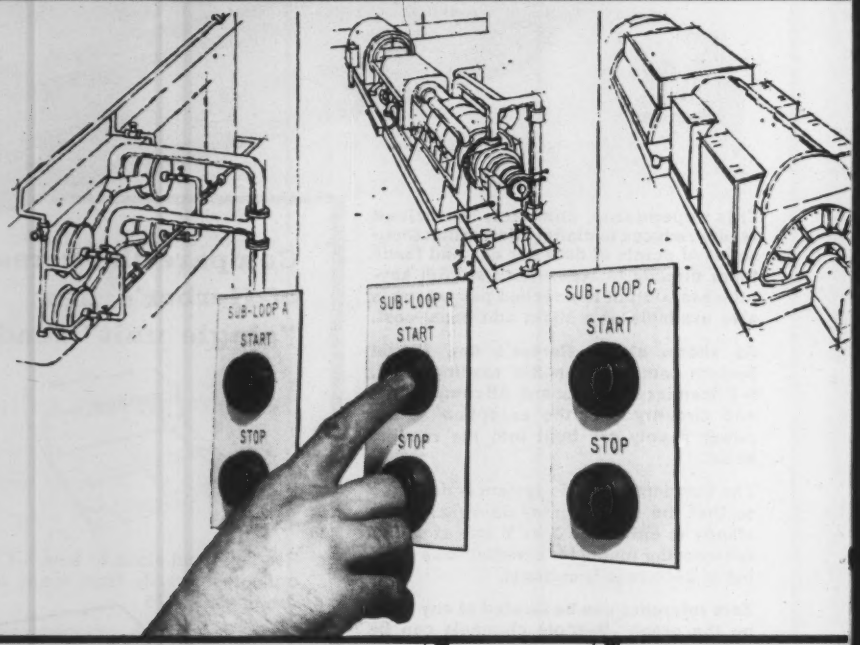


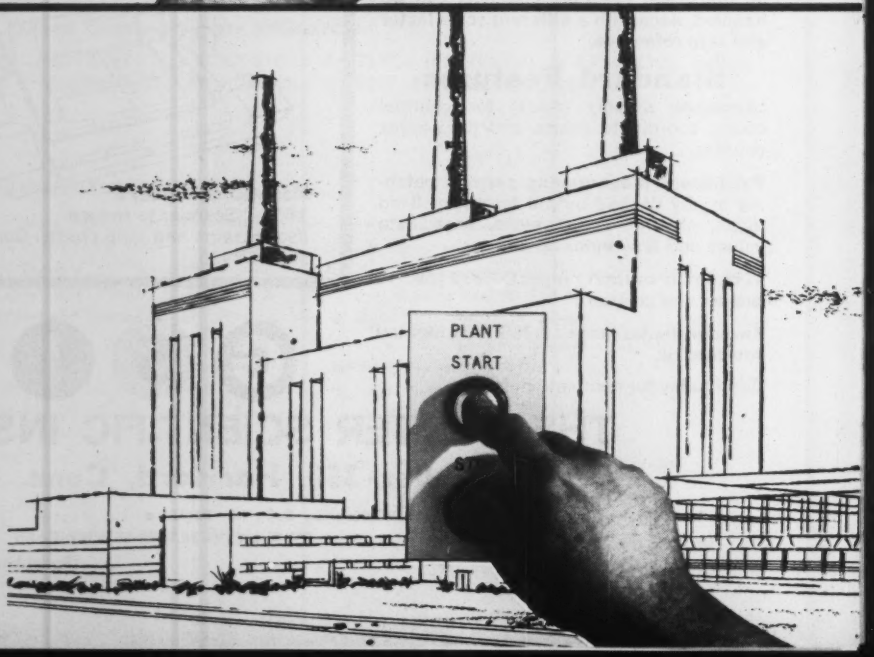
FIRST SIMPLIFY...

First step to automation is to *simplify* the information now presented by a multitude of multi-record charts, gages, and annunciator lights. The Bailey approach gives the operator data he needs (logged periodically), keeps continuous watch on all variables, makes calculations where required, alarms when trouble threatens. Reliability of recorded data is increased . . . operators can devote full attention to correcting off-normal conditions and improving operations.



NEXT VERIFY...

Next, verify the practicability of automation by extending supervisory controls, letting equipment perform more operating functions. Automate key systems, one at a time, by push-button controlled sub-loops. This approach smooths the transition to complete automation and improves safety to men and machinery by providing safe, uniform start-up, shut-down, and normal operating procedures.



THEN AUTOMATE

Final steps to automation can then be made at any time with full confidence and proved operational experience. These steps are: 1) to consolidate supervisory controls, conventional controls, and sub-loops for full-range automatic operation once the plant has been placed on the line; and 2) ultimately, to add start-stop control to provide full automation.

How to get *assured results* from AUTOMATION

...and gain as you go

Complete automation is a long step forward — with many challenges along the way.

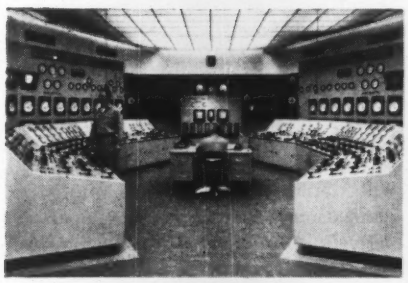
The Bailey step-by-step approach to automation makes possible step-by-step certainty ... provides step-by-step benefits ... requires only step-by-step commitment.

In the initial steps it makes possible many or most of the benefits of complete automation with considerably less investment than required for the ultimate. And it permits the decision to take each succeeding step to be made only after satisfactory evidence that it is economically justified and functionally sound.

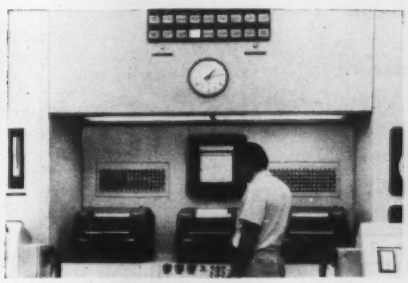
Bailey 700 Systems draw on the best available techniques, including analog and digital manipulation, trend recording, time sharing, scanning, alarming, calculating, controlling, and logging, as required to meet operating objectives. Individual systems, including logic and sequence units, are coordinated by Bailey's distinctive method of *parallel programming* to achieve plant automation. The parallel-programming approach improves plant availability by making it practical to remove individual systems from service or reprogram without disturbing operation.

Ask your Bailey District Office, or write for more information on the Bailey step-by-step approach to automation with Bailey 700 Systems. Bailey Meter Company, 1069 Ivanhoe Road, Cleveland 10, Ohio. In Canada —Bailey Meter Company Limited, Montreal.

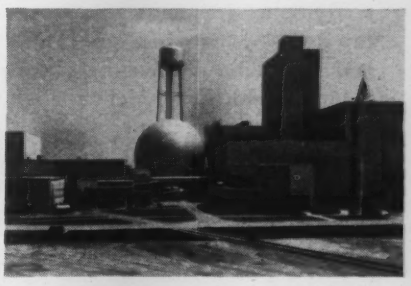
Bailey Systems Concepts are Founded on 45 years of Experience



Twenty-one of the twenty-six most efficient steam-electric stations in the United States use Bailey Instruments and Controls.* This reflects more than 45 years of Bailey developments devoted to improving the reliability of power-plant operation. **Listed in Federal Power Commission Report S-143.*



Bailey experience in automation dates from electrically operated boiler controls in 1924, automatic start of boiler controls on steam-electric locomotive in 1936, and fully automated package boilers in 1948. This Bailey 750 System for simplified display of power-plant operating information was installed in 1959.



Bailey experience extends to and includes the atomic power field. In the completion of the Enrico Fermi Atomic Power Plant at Monroe, Mich. in 1961, Bailey Meter Company was prime instrument contractor, supplying both pneumatic and transistorized electronic control systems. A165-2

BAILEY METER 700 SYSTEMS

BAILEY METER COMPANY

700 Systems

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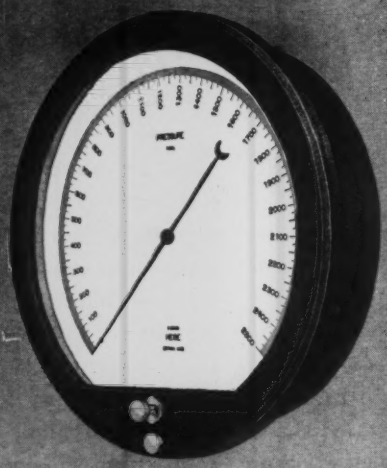
HEISE GAUGES

Corrosion Resistance

IN ULTRA HIGH PRESSURE INSTRUMENTS

Modern laboratory applications frequently require resistance to corrosive and semi-corrosive fluids as well as peak performance in ultra high pressure ranges. Heat treated 403 Stainless Steel, in an exclusive weldless Bourdon tube, provides superior service under the most critical conditions. Heise Gauges are frequently specified for use with mercury as a pressure medium.



0.1% F.S.R. Accuracy is guaranteed at pressures up to 100,000 p.s.i. by the Heise Multi-coiled Tube. This stainless steel tube is a weldless one piece element which completely eliminates all internal connections.

Premium instrumentation requires Heise Gauges.

Dial Sizes	FULL SCALE READING (P.S.I.)						
	0-15 to 0-5,000 inclusive	Over 0-5,000 and including 0-20,000	Over 0-20,000 and including 0-30,000	0 to 40,000	0 to 50,000	0 to 75,000	0 to 100,000
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CIRCLE 6 ON READER-SERVICE CARD

I&CS NEWS

National Conference of Standards Laboratories

WASHINGTON, D.C.—A new organization, the National Conference of Standards Laboratories (NCSL), recently was established by representatives concerned with standards activities in Government, industry, education, and professional societies. The objectives of the NCSL are to: (1) determine the requirements of science and industry for greater precision in measurement, (2) increase the overall competence of standards laboratories by the development of uniform practices relating to organization, staffing, and operation, (3) provide opportunity for voluntary participation in measurement agreement operations to demonstrate competence and continued uniformity among standards laboratories.

In August 1962 the first Standards Laboratory Conference will be held at the National Bureau of Standards' Boulder Laboratories, Boulder, Colorado. Its efforts will be directed towards solving the problems faced by standards laboratories in their organization and operation. Organizations which indicated an interest in NCSL at the time it was formed included the National Bureau of Standards, Department of Defense, Instrument Society of America, Precision Measurements Association, American Society for Testing Materials, American Standards Association, and the Institute of Radio Engineers. NCSL is not intended to be an organization which will duplicate work of existing organizations. Instead, it will cooperate actively with such existing organizations by calling their attention to the problems faced by the standards laboratories and by requesting these organizations to take whatever action they can to assist in solving these problems. In areas where the need is urgent, the NCSL will undertake solutions on its own.

Officers of NCSL are Lloyd B. Wilson, Chairman, (Sperry Gyroscope Co.), Charles E. Johnson, Vice-Chairman, (Boeing Co.), and Harvey W. Lance, Secretary (Boulder Laboratories, NBS).

Control Courses Offered by Honeywell

PHILADELPHIA, PA.—Two special courses, "Control Dynamics" and "Fundamentals of Instrumentation," are being offered in 1962 in addition to regular instrument services and maintenance classes.

"Control Dynamics" is an intensive five-day course for instrument and systems engineers covering nonmathematical techniques for evaluating process dynamics in solving automatic control problems. Sessions will be held April 9-13 and October 1-5, 1962. Registration fee is $100.

"Fundamentals of Instrumentation," a 10-day course to be held three times during the year—March 5-16, June 18-29 and October 22-November 2—is primarily for engineers with little or no instrument experience and for those needing to review the principles of conventional instrumentation. Each course is limited to 15 students. Write to Clarence A. Dyer, Instrumentation Education Center, Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Phila. 44, Pa.

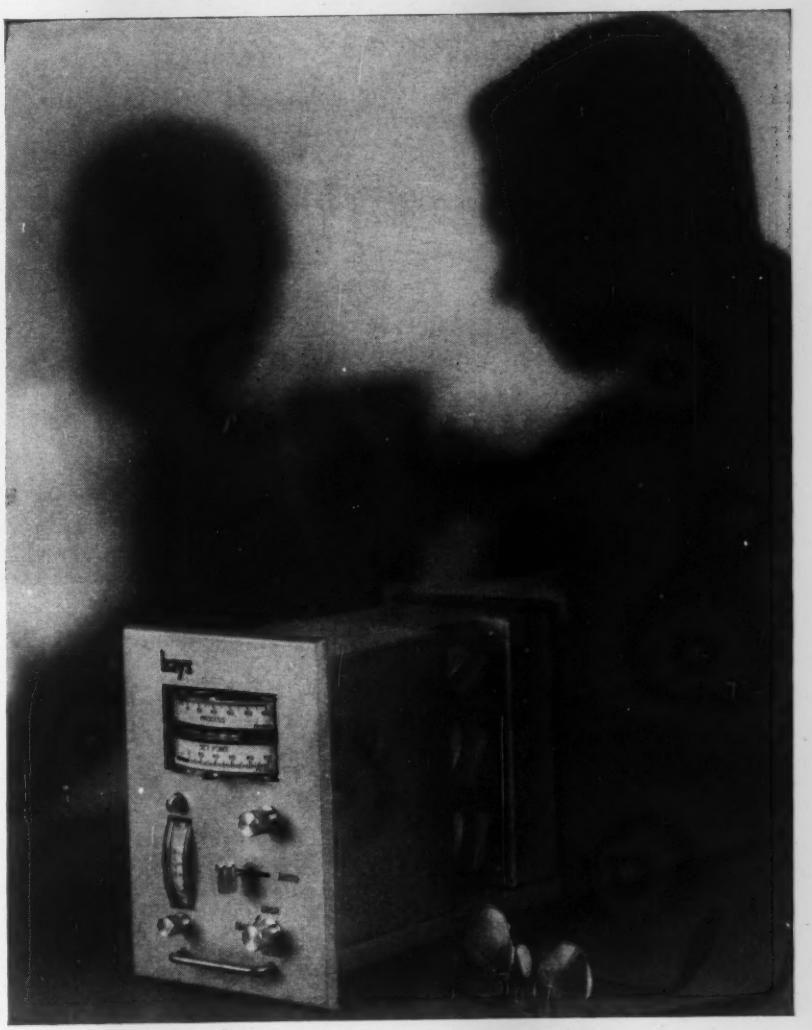
CIRCLE 170 ON READER-SERVICE CARD

ADAGE, INC. announces appointment of *Irving R. Schwartz* as sales

Irving R. Schwartz

Robert W. Brooks

manager, and of *Robert W. Brooks* as Product Department manager.



"A new Universal controller, you say?"

"Yep . . . a complete control station in itself."

Will accept current or retransmitting slidewire inputs for both process variable and cascaded set points—all inputs and the output are isolated with either continuous current or relay output versions available.

Full details in Bulletin B850

THE hays CORPORATION · MICHIGAN CITY, INDIANA

CIRCLE 7 ON READER-SERVICE CARD

MODEL 8010—$452.50
10Mv to 100V span

POTENTIOMETRIC

Graphicorders®

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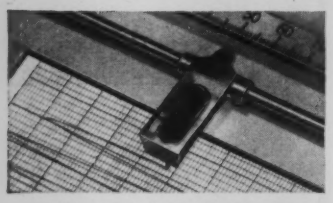
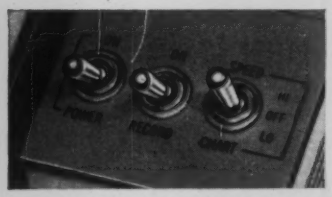
FAST RESPONSE TIME—½ sec. full scale
HIGH SENSITIVITY—¼% of span
Zener diode reference system • Two chart speeds



Transparent capillary pen with large ink reservoir is easily aligned, cleaned, filled or removed.



Selection of two charts speeds is made with fingertip control. No motor or gear changes are necessary.

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(*Models 8020 and 8021 are specifically designed for gas chromatography.*)

Dynatronic Graphicorders are the finest, yet lowest price recording instruments available, today. There is no need to pay more . . . no need to settle for less!

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Computer Used in Paper Manufacturing

LEWISTON, IDAHO—The "first process control system for the paper manufacturing industry" was unveiled November 2 at the Lewiston, Idaho plant of Potlatch Forests, Inc.

The system—an IBM 1710—combines a 1711 analog-to-digital converter and a 1620 digital computer, and ties in to 46 points on the "wet end" or Fourdrinier of one of PFI's two multi-grade papermaking machines.

So far the system is an open-end one, with no feedback controls. Current operations involve the use of the

1710 as a data logging system in an attempt to collect enough data to establish an accurate mathematical model of the "wet end" process.

The collected data will be submitted to regression and correlation analysis on the 1620 to establish the exact relationships of the variables which make up the papermaking process. Once these relationships have been established, Potlatch Forests will be able to formulate the instrumentation settings and controls required by the various grades of paper produced at the company's Clearwater plant.

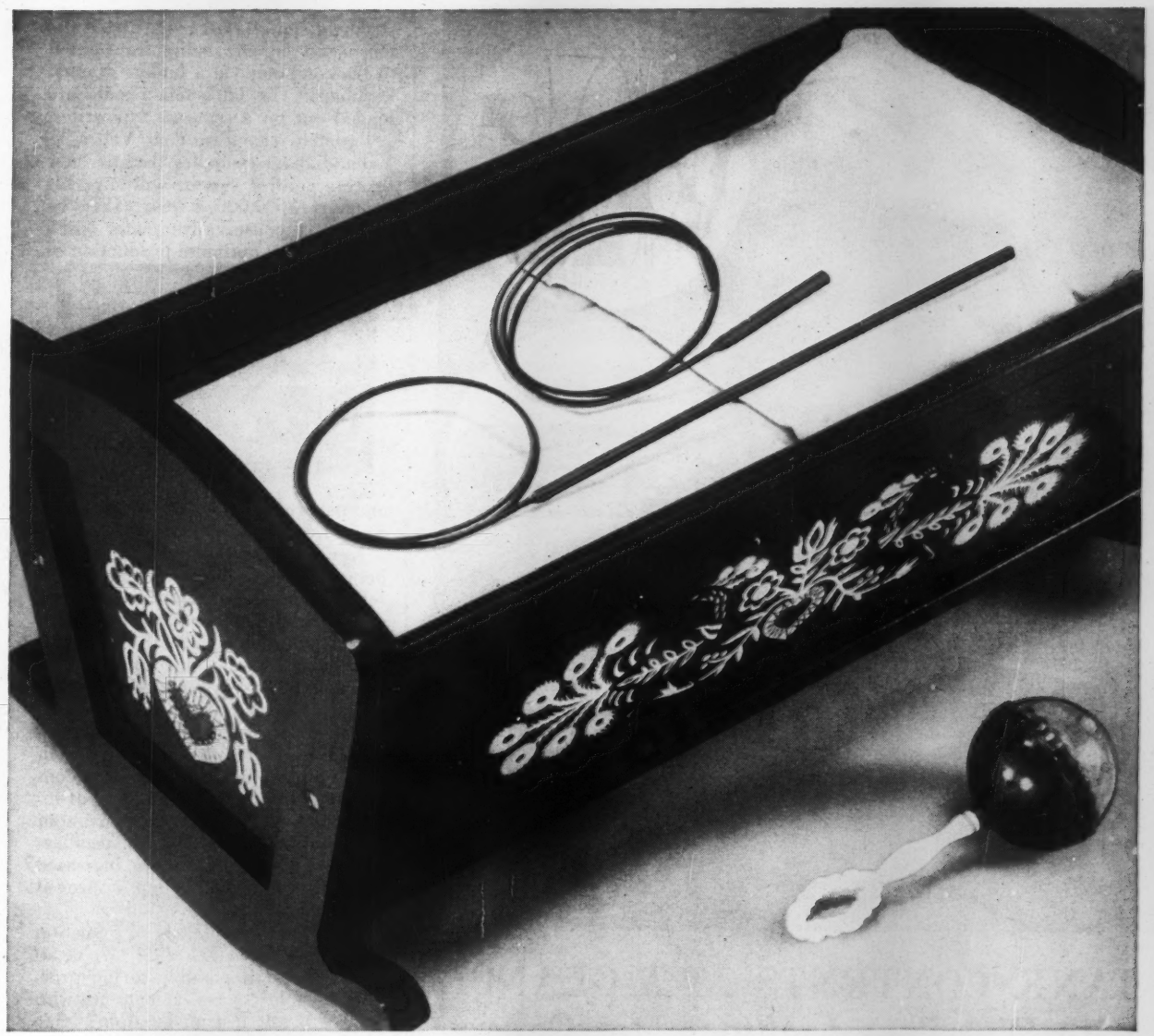
Beginning some time next year, Potlatch plans to begin closing the loop—using the computer to control some of the points on the paper machine. Later, a second paper-making machine will be tied in to a computer.

The 46 process instrumentation stations currently connected to the 1710 are all located prior to or on the Fourdrinier. This represents the foundation of papermaking, where caliper and strength are built into the paper.

The system uses Minneapolis-Honeywell pressure-to-current transducers which transmit a 4-to-20 milliamp signal. Transmitted a maximum distance of 600 feet, the signals are fed to a common terminal box wired to the 1711 data converter in the computer room. Some 11 to 12 transducers are used to measure water balance alone.

In addition to paper machine in-

(*Continued on page* 2174)



New from Kensico: one-piece capillary tube and bulb assembly, in sizes for all types of instrumentation work. This new one-piece assembly for thermosensing elements is painstakingly produced by Kensico technicians using the utmost care to insure customer's exact specifications. Range offered includes bulb sizes up to ⅜" OD maximum, by any desired length, with capillary tubing down to a minimum of 0.010" ID.

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Single-piece design eliminates a joining operation in the assembly of instrumentation systems and gives the added efficiency of joint-free flow. Kensico normally ships these units in straight lengths although they are shown above coiled to indicate design. Call Kensico today. Discover how well deserved is our reputation as a Small Tube Specialist. Write KT-61, Kensico Tube, Mount Kisco, N.Y. for free copy of Air Flow Engineering Charts.

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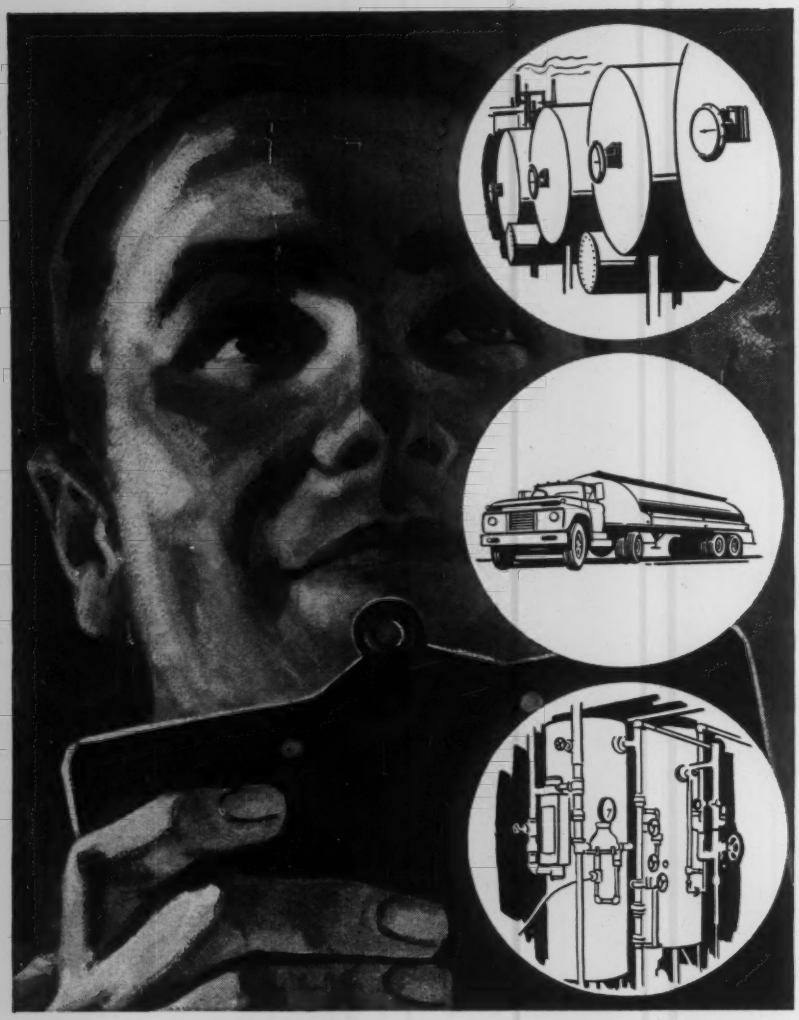
Robinson Technical Products, Inc. • MOUNT KISCO, NEW YORK

Kensico Products are also available through Warehouse Distributors and Sales Representatives in Cambridge, Mass.; Middlebury, Conn.; Buffalo, N. Y.; Lindenhurst, N. Y.; Goshen, N. Y.; Roselle, N. J.; Philadelphia, Pa.; Flourtown, Pa.; Pittsburgh, Pa.; Cleveland, Ohio; Chicago, Ill.; St. Louis, Mo.; Milwaukee, Wisc.; Durham, N. C.; Dallas, Texas.

CIRCLE 9 ON READER-SERVICE CARD



TANK CONTENTS AT-A-GLANCE with Dial-Type Liquidometer Gauges

For added assurance of accurate liquid quantity record keeping, specify easy-to-read Liquidometer gauges. Positive dial-and-pointer type indicators help to prevent erroneous readings . . . speed record keeping by showing tank contents at-a-glance.

Liquidometer gauges are available to measure and indicate virtually any liquid – at the tank site or remotely. Also available: integral or separate liquid level switches for automatic level warning or control. Float, hydrostatic, electric, or electronic operation can be supplied to meet your specific needs.

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CIRCLE 10 ON READER-SERVICE CARD

strument signals, test results from the paper test lab are being transmitted to the computer via a remote manual keyboard. The lab's test results are logged out on a separate typewriter.

Potlatch Vice President Vance V. Vallandigham estimates that the new process control system will save his company $600,000 a year. This, he says, is a conservative guess based merely on the optimum production of

one papermaking machine which the control system will make possible.

Key to the savings is the difference between the current production rate for one machine of 250 tons per day and its maximum capacity of 300-plus tons. The lost time, according to Vallandigham, lies in the changes required in reels, calipers, color and weight as paper grades are changed. There are an average of 6.5 changes a day, which require anywhere from 10 minutes to an hour each. The continuous instantaneous sampling of instruments—with immediate printout of deviations from standard specifications—will mean not only increased machine productivity, but improved paper quality as well.

Too, says Potlatch Production Manager Donald T. Keller, "We've already found it possible to log process variables unavailable to us with conventional instrumentation." One such variable is the velocity in feet-per-minute of the stock as it leaves the slice—the opening in the headbox from which it flows into the first stage of the dehydrating and paper forming process. The stock velocity out of the slice is calculated, then back-checked by instrument measurement of the flow. The slice opening itself is measured by a motion transmitter—a variable slide wire contactor.

One of the final benefits of the process control system has been its use to help calibrate the instruments themselves . . . result of a better understanding of the interlocking variables and their effects upon each other. Eventually, the 1620 will be used for production scheduling and inventory control.

Currently, the 1710 installation is costing Potlatch Forests $3500 month. Of this, approximately half is for the

(*Continued on page* 2176)

this is the Brush Mark II... anyone can plug it in put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

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37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

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COUNT ON THE NEW W&T SERIES 100 PUMP WHEN YOU NEED...

...ACCURATE METERING WITH SMOOTH CONTROL

Wallace & Tiernan's newest plunger pump delivers 3.2 gph vs 1200 psi to 50 gph vs 100 psi, repeatable within ± 1%. Easy adjustment over 10:1 range with the pump running.

...DOUBLE CAPACITY OR TWO-LIQUID METERING

A second liquid end doubles capacity or gives simultaneous feeding of two liquids. Stroke length for each end individually adjusted.

...DEPENDABLE, TROUBLE-FREE METERING

Unitized construction means the Series 100 Pump stays in perfect alignment. Wear and maintenance are held to a minimum. Corrosion-resistant wetted parts handle most chemicals. The Series 100 Pump, with motor, is compact. With two liquid ends it occupies less than 2 sq. ft.

For more information write Dept. L-8.48

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CIRCLE 12 ON READER-SERVICE CARD

1711 and related gear, with the rest used up by the 1620 computer on the basis of actual computing time for one 176-hour-a-month shift. Right now, the computer is being used less than an hour and a half a day.

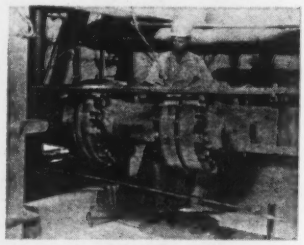
The load—and the rental—will increase as more data are accumulated and as more points in the process are tied into the system. Later Potlatch will probably add to the computer's present memory of 20,000 characters (maximum 1620 capacity is 60,000 characters), and may even install a special 1710 Ramac disc file, which will give the system an additional capacity of one-million characters.

Feasibility studies for the process control system began in 1959, and Potlatch announced their intention of installing the 1710 in May, 1961.

CIRCLE 371 FOR MORE INFORMATION

30,000-gpm Flowmeters built for F-1 Rocket Engine

HATBORO, PA.—14″ turbine-type flowmeters are used at NASA facilities located at the High Thrust Test Area, Edwards, Cal. to measure LOX



(liquid oxygen) and RP-1 (rocket propulsion fuel No. 1). Flow rates climb to 30,000 gpm during brief tests of the F-1 rocket engine, the 1.5-million-pound thrust engine that Rocketdyne, a division of North American Aviation, Inc., is developing for advanced NASA space vehicles such as the Saturn C-3 and Nova.

Within 1¼ seconds, flow goes from 0 to full rated and back again. The extremely high measurement capacity is needed to measure fuel flow when all eight of Nova's F-1's would consume prodigious volumes of oxidizer and fuel to develop their total thrust of 12 million pounds. This booster power would launch the Apollo, the space ship intended to carry a three-man crew to the moon.

Fischer & Porter Company, Warminster, Pa., engineered and built the three big 14″ ID stainless steel flowmeters specifically for the thrust chamber studies of impulse starts of the F-1. One flowmeter is a standby.

CIRCLE 372 FOR MORE INFORMATION

NBS Discontinues Certification of Unsaturated Standard Cells

WASHINGTON, D. C.—NBS has discontinued the certification of emf of unsaturated standard cells as of June 30, 1961. An exception will be made for public utilities and other agencies having operations of such a nature as to require these services from the Bureau.

Standard cells submitted in the past to the Bureau for certification have fallen into two groups—saturated and unsaturated. The saturated cells have the better performance, and their electromotive force (emf) may be certified to 0.0001 percent. The unsaturated cells are used as working standards where the accuracy required is no greater than 0.01 percent. The most prevalent use of unsaturated cells is by power companies and instrument calibrating laboratories as a reference emf with potentiometers.

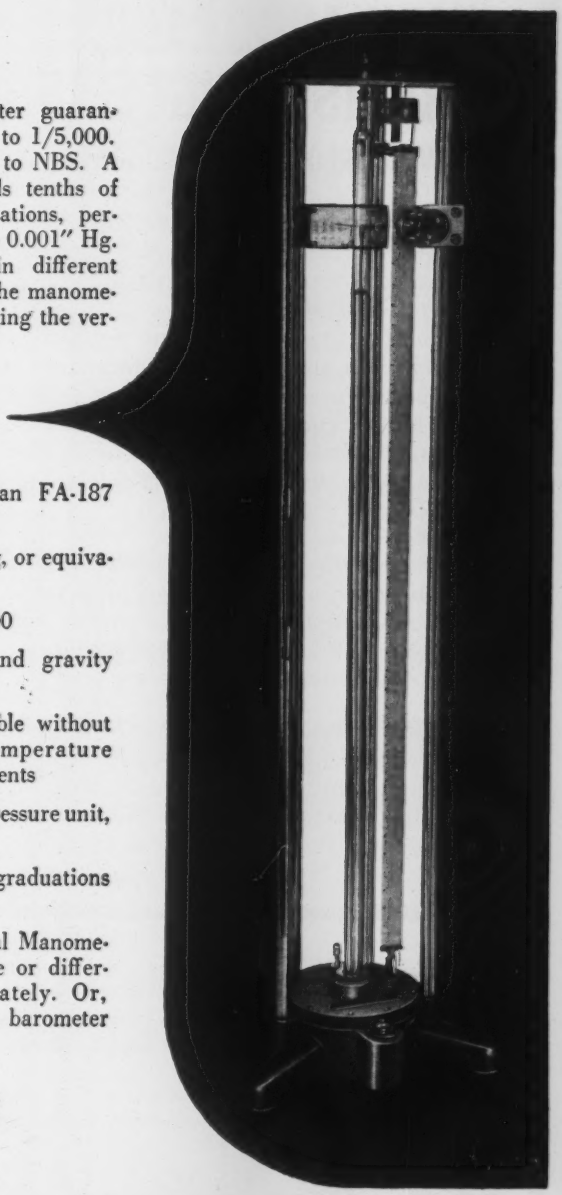
Computer Management Control for Textiles

CLEMSON, S. C.—A new computer technique called MOS (Management Operating System) for Textiles provides up-to-the-minute information on a day-to-day basis by performing such vital operational functions as inventory control and preparation of manufacturing orders. The new system utilizes the high processing speed and large storage capacity of the solid-state IBM 1401 and 1410 data processing systems equipped with RAMAC disc files. Programs tailored specifically to the requirements of any textile manufacturing operation can be based on the general logic of MOS for Textiles. This logic, in the form of flow charts and block diagrams, is available without charge from International Business Machines Corp., Data Processing Div., 112 E. Post Rd., White Plains, N. Y.

CIRCLE 171 ON READER-SERVICE CARD

For More Information Please Circle the Corresponding Number on the Reader Service Card.

GET W&T U-Tube accuracy with Fast, Direct Readout.. PRECISION MERCURIAL MANOMETER



The FA-187 Manometer guarantees readings accurate to 1/5,000. Accuracy is traceable to NBS. A magnetic vernier reads tenths of the main scale graduations, permits direct readings to 0.001" Hg. Five vernier scales in different units allow changing the manometer scale without changing the vernier.

The Wallace & Tiernan FA-187 Manometer also gives:

- ★ Range: 800 mm. Hg, or equivalent
- ★ Sensitivity: 1/25,000
- ★ Full temperature and gravity compensation
- ★ Scales interchangeable without recalibration of temperature and gravity adjustments
- ★ Calibration in any pressure unit, or equivalent
- ★ One or two sets of graduations on a single scale

Use the W&T Mercurial Manometer to measure absolute or differential pressures accurately. Or, quickly convert it to a barometer on the job.

For more information, write Dept. A-134.48

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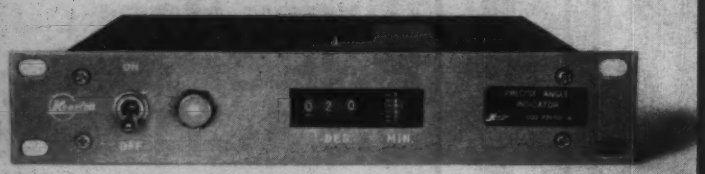
CIRCLE 13 ON READER-SERVICE CARD



HIGH-ACCURACY PRECISE ANGLE INDICATOR

NEW KEARFOTT UNIT ACCURATE TO ±6 MINUTES

The new CO 2721011 Precise Angle Indicator features an accuracy of ±6 minutes. Latest addition to the Kearfott line of standard test equipment, the unit is designed to meet a wide range of applications. Typical Applications • Indication of gyro angle of pitch, roll, or yaw and relaying of signal to any preselected impedance or voltage level. • Indication of shaft position of remote synchro or resolver, and transmission of this information to any impedance or voltage level. • Display of difference between two shafts when driven by transmitter and differential synchros.

In addition to high accuracy the instrument combines a number of other prominent advantages: it requires only a single power source; it has good sensitivity; it is designed for modular application; and it offers direct automatic read-out. The unit is of extremely compact construction and is built for maximal ease of maintenance.

The low-cost CO 2721011 Precise Angle Indicator is available with a single sensor, auxiliary dual-input sensor, or an auxiliary retransmitter. For additional information on this new test instrument, write for the brochure which describes its operation and capabilities in detail.

SPECIFICATIONS

Repeatability	±1.2 min	**Slewing Speed**	7 sec/180°
Readability	0.5 min	**Power (single source)**	115 v, 1φ, 400 cps
Input Power	30 va	**Size**	1¾ x 9½ x 9⅛ in.
Sensitivity	1.0 min	**Weight**	4 lbs.

Write for complete data

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CIRCLE 14 ON READER-SERVICE CARD

New **ISA RECOMMENDED PRACTICES** are: RP16.5 "Installation, Operation, Maintenance Instructions for Glass Tube Variable Area Meters (Rotameters)"; RP20.2 "Specification Forms for Resistance Bulbs, Gauge Glasses & Cocks, Pressure and Temperature Switches, Level Switches, Steam Traps & Drainers and Miscellaneous Instruments"; RP16.6 "Methods and Equipment for Calibration of Variable Area Meters (Rotameters)"; RP23.1 "Miniature Recorder Chart Ranges"; RP26.4 "Dynamic Response Testing of Process Control Instrumentation—Part IV, Closed Loop Actuators for Final Control Elements"; RP31.1 "Terminology and Specifications for Turbine-Type Flow Transducers (Volumetric)." Available from Instrument Society of America, 530 William Penn Place, Pittsburgh 19, Pa.

INDUSTRIAL INSTRUMENTS INC. announces appointment of

Ronald S. Pittenger

Ronald S. Pittenger as advertising and sales promotion manager.

System Proves Oil Line Flowmeters

TULSA, OHIO.—A Halmor Meter Prover System which enables an American oil firm to check their pipe line meters has been shipped to Libya by J. A. Halpine & Son, Inc., Box 6147, Pine St. Station, Tulsa. The Prover barrel consists of a 36″ steel tube 160 ft long with a 16″ manifold valve that directs the flow. Components of the system include a Halmor tachometer or pulse generator driven by the meter that generates 1,000 pulses per revolution of the meter shaft; a piston barrel and associated switching manifold, two Halmot piston switches, one electric counter and finally, the meters that require calibration. Halmor Liquid-Meter Prover Systems permit positive-displacement meters to be proved within a few minutes and eliminate start and stop errors.

CIRCLE 172 ON READER-SERVICE CARD

BOOKS

How to Use Grid-Dip Oscillators by Rufus P. Turner, [c 1960] John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 112 pp., 8½", paperbound, $2.50.
CIRCLE 173 ON READER-SERVICE CARD

Magnetic Amplifiers, Principles and Applications, by Paul Mali, [c 1960] John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 112 pp., 8½", paperbound, $2.45.
CIRCLE 174 ON READER-SERVICE CARD

ABC's of Radar by Alan Andrews, [c 1961] Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind. 112 pp., 8½", paperbound, $1.95.
CIRCLE 175 ON READER-SERVICE CARD

Kinetics, Equilibria & Performance of High Temperature Systems, edited by Gilbert S. Bahn and Edward E. Zukoski, [c 1959] Western States Section The Combustion Institute; Butterworth, Inc., 7235 Wisconsin Ave., Washington 14, D. C. 255 pp., 10", $12.50.
CIRCLE 176 ON READER-SERVICE CARD

Magnetic Tape Instrumentation by Gomer L. Davies, [c 1961] McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 272 pp., 9", clothbound, $8.50.
CIRCLE 177 ON READER-SERVICE CARD

The Rate Gyroscope by Ralph H. Johnston, [c 1960] R. C. Allen Business Machines, Inc., Aircraft Instrument Division, 333 Commerce Ave., S. W., Grand Rapids, Mich. 55 pp., 8¼", spiralbound, $3.00.
CIRCLE 178 ON READER-SERVICE CARD

Management Organization and the Computer, edited by George P. Shultz and Thomas L. Wishler, [c 1960] Graduate School of Business, The University of Chicago; The Free Press of Glencoe, Ill. 257 pp., 9¼", clothbound, $7.50.
CIRCLE 179 ON READER-SERVICE CARD

Shock and Vibration in Linear Systems by Paul A. Crafton [c 1961], Harper & Brothers, 49 East 33rd St., New York 16, N. Y. 415 pp., 9¼", clothbound, $10.00.
CIRCLE 180 ON READER-SERVICE CARD

DEC Building Block Logic, [c 1960] Digital Equipment Corporation, Maynard, Mass. 48 pp., 8½", paperbound, $1.00.
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TRINITY's MP-60 operates with inlet air at any pressure from 10 PSIG to 90 PSIG • Shipped ready-to-operate with both chambers charged with activated alumina desiccant • Delivers dry air with a dewpoint 100°F below ambient temperature, or better • Always ready to deliver dry air when used continually • Easy to install • Needs only 8⅞" x 21" x 7" wall space.

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Ranges: 0-10 psi to 0-100 psi.
Non-linearity and hysteresis: Less than ±1.0% of full scale.
Transduction: Resistive, complete strain gage bridge.
Available for absolute, gage or differential pressure measurements.

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CIRCLE 16 ON READER-SERVICE CARD

ASM Metals Handbook, Eighth Edition, Vol. 1., "Properties and Selection of Metals," edited by Taylor Lyman, [c 1961] The American Society for Metals, Metals Park, Novelty, Ohio. 1300 pp., 8½″ x 10⅞″, clothbound, $30.00.

CIRCLE 182 ON READER-SERVICE CARD

INTERKAMA 1960, Reports from the International Congress for Measuring Technique and Automation 1960, R. Oldenbourg, Rosenheimerstrasse 145, Munich, West Germany. 304 pp., 8¼″ x 10¾″, clothbound, DM 55.00.

CIRCLE 183 ON READER-SERVICE CARD

Photoelasticity, Principles and Methods by H. T. Jessop and F. C. Harris [c 1949] Cleaver-Hume Press Ltd., 42A South Audley St., London W.1., U.K. Dover Publications, Inc., 180 Varick St., New York 14, N. Y. 184 pp., 8″, paperbound, $2.00.

CIRCLE 184 ON READER-SERVICE CARD

Physics, The Pioneer Science, Vol. 1, Mechanics, Heat, Sound, by Lloyd W. Taylor [c 1941], Dover Publication, Inc., 180 Varick St., New York 14, N. Y. 451 pp., 8⅜″, paperbound, $2.00.

CIRCLE 185 ON READER-SERVICE CARD

Physics, The Pioneer Science, Vol. 2, Light, Electricity, by Lloyd W. Taylor [c 1941] Dover Publications, Inc., 180 Varick St., New York 14, N. Y. 897 pp., 8⅜″, paperbound, $2.00.

CIRCLE 186 ON READER-SERVICE CARD

Classical Mechanics by H. C. Corben and Philip Stehle, Second Edition, [c 1960] John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y., 389 pp., 9″, clothbound, $12.00.

CIRCLE 187 ON READER-SERVICE CARD

Practical Robot Circuits, Second (revised) Edition, by A. H. Bruinsma, translated by E. Harker, [c 1959] N. V. Philips Gloeilampenfabriken, Eindhoven, Holland, The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 74 pp., 8″ clothbound, $3.95.

CIRCLE 188 ON READER-SERVICE CARD

Technical Communication by George Harwell [c 1960] The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 332 pp., 8¼″, clothbound, $5.00.

CIRCLE 189 ON READER-SERVICE CARD

How to Use Meters, Second edition, by John F. Rider & Sol D. Prensky, [c 1960] John F. Rider Publisher, Inc., 116 W. 114 St., New York 11, N. Y. Cat. No. 144. 216 pp., 8½″, paperbound, $3.50.

CIRCLE 190 ON READER-SERVICE CARD

CIRCLE 17 ON READER SERVICE CARD ⟶

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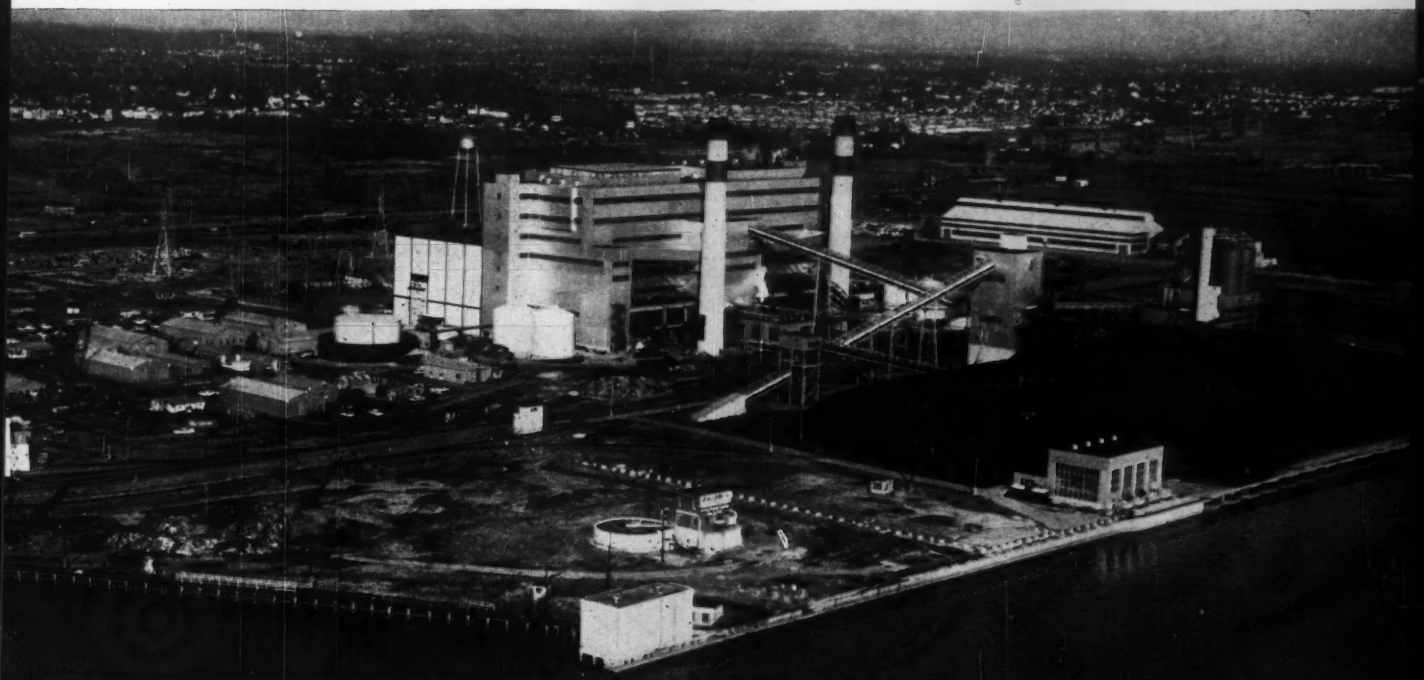
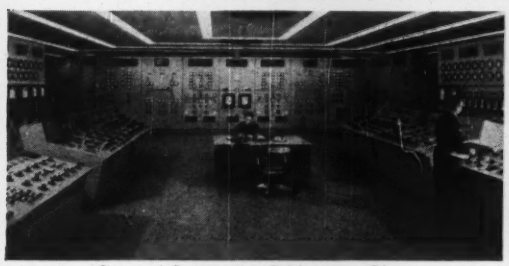
Swagelok®

Philadelphia Electric Company's new Eddystone Station is an engineering achievement of which Americans can be proud. Representing a major breakthrough in the power industry, the Eddystone Electric Generating Station was designed as the world's most efficient power plant. This improvement in efficiency has been achieved by generating steam at a supercritical pressure of 5000 pounds per square inch and a temperature of 1200° F.

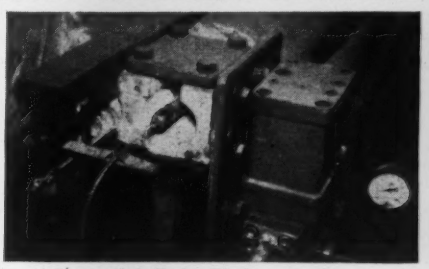


Philadelphia Electric Generating Station at Eddystone on the Delaware River near Philadelphia.

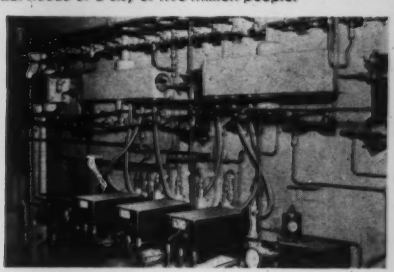
Housing two 325,000 kilowatt turbine generators, this giant station can produce enough power to supply the residential needs of a city of five million people.



Control Center for Eddystone Plant Operation.



Swagelok Tube Fitting used as a thermocouple connector on main steam header #1 for boiler control. Operating conditions: Steam at 5000 psig — 1200° F.



Swagelok Tube Fittings used in control systems of supercritical pressure boiler.

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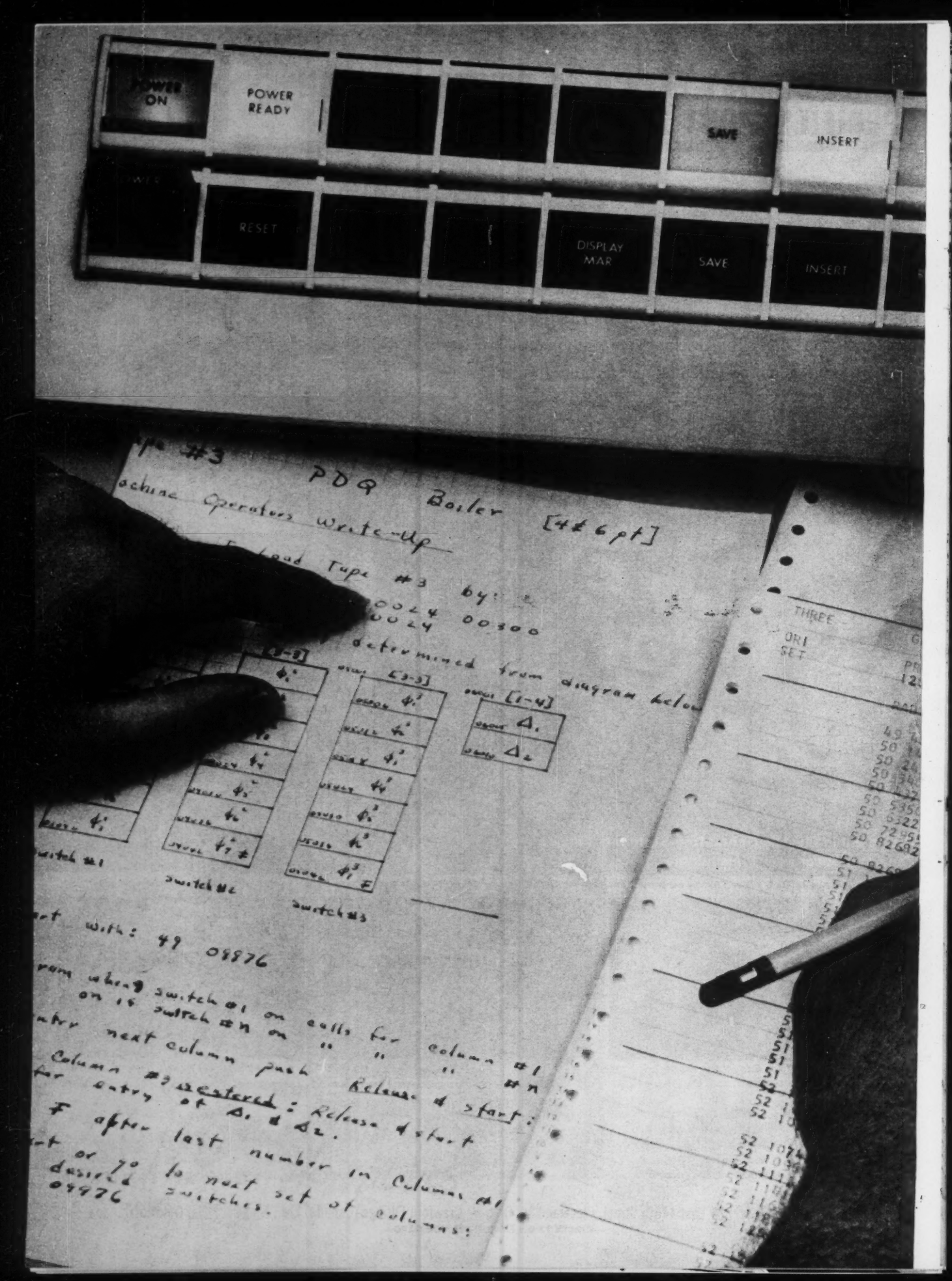
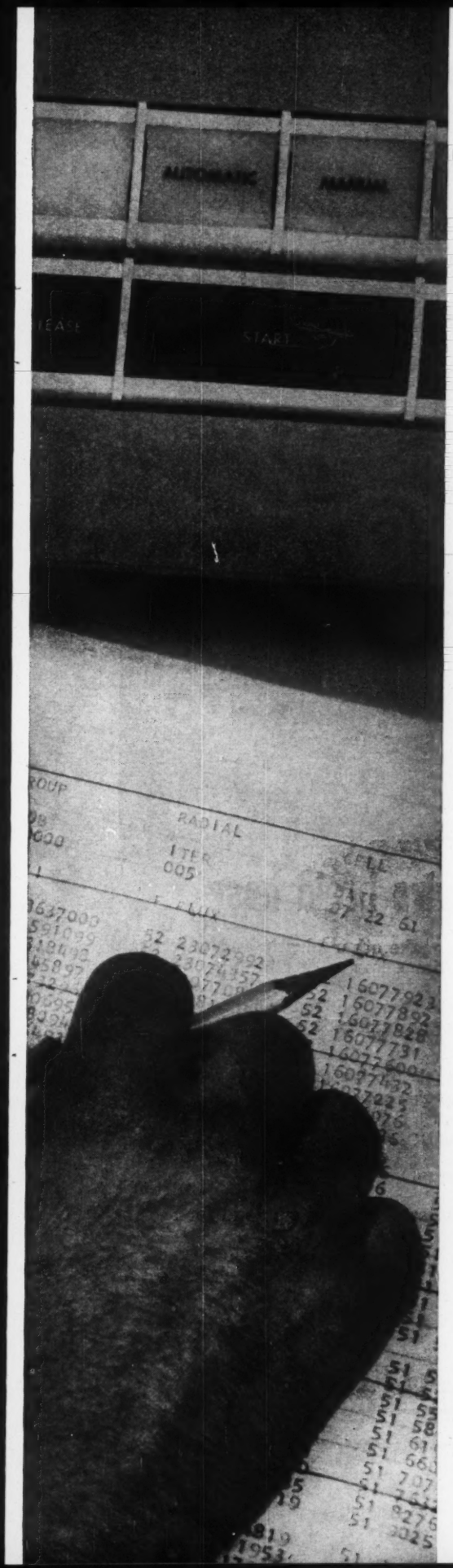
Crawford Fitting Company, 884 East 140th Street, Cleveland 10, Ohio • Crawford Fittings (Canada) Ltd., Niagara Falls, Ontario, Canada

CIRCLE 17 ON READER-SERVICE CARD


POWER ON
POWER READY
SAVE
INSERT
RESET
DISPLAY MAR
SAVE
INSERT
#3
PDQ Boiler [4 & 6 pt]
achine Operators Write-Up
switch #1
switch #2
switch #3
Column #3 entered: Release & start:
for entry of Δ1 & Δ2.
F after last number in Columns #1
rt or 7° to next set of columns:
04976
switches.



Cost of one-dimensional criticality computations drops from an average of $75.00 to $7.50 per problem

Faster computing, less travel time are the reasons why General Nuclear Engineering Corporation has realized such cost savings since it installed an IBM 1620 Data Processing System at its Dunedin, Florida plant.

Since its main computing facilities are not located at Dunedin, General Nuclear has found that the new 1620 eliminates much of the travel time and expense involved in taking problems to off-site computers. In addition, the 1620 performs the simpler criticality computations 10 times faster than the computer previously used at one of General Nuclear's off-site data processing centers.

General Nuclear uses its new 1620 for other problems, too...heat transfer calculations, various transient codes, mathematical routines for the physics and engineering departments, multi-group calculations, and many other jobs you might expect only a much more expensive computer to be able to handle.

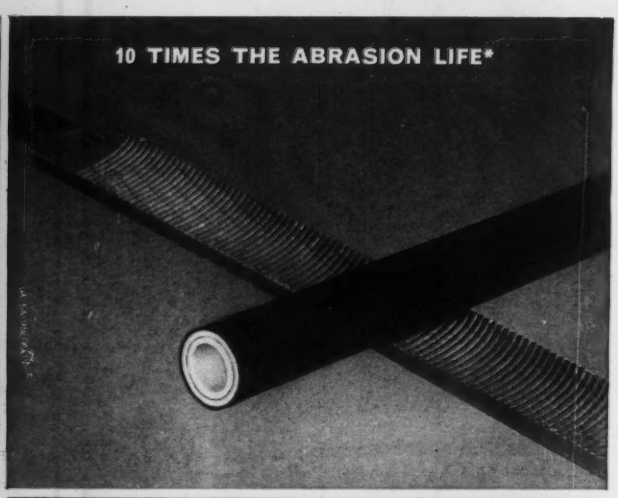
This isn't all. General Nuclear uses the 1620 to do statistical analyses and variance calculations on input data for programs run on off-site large-scale IBM computers.

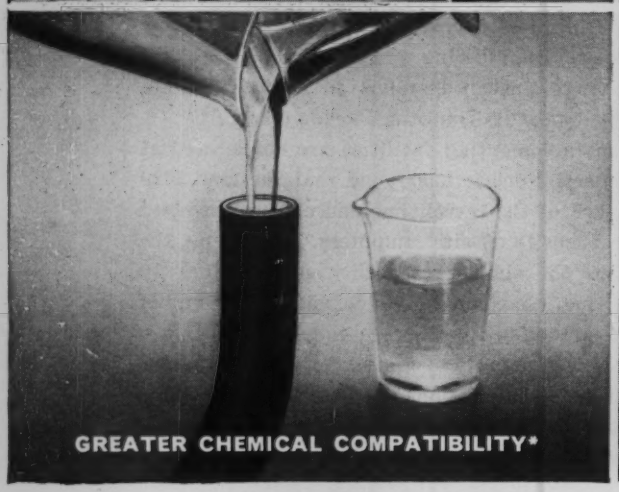
For information on this highly versatile, low-cost data processing system, which rents for as little as $1600 a month, contact your local IBM Representative.

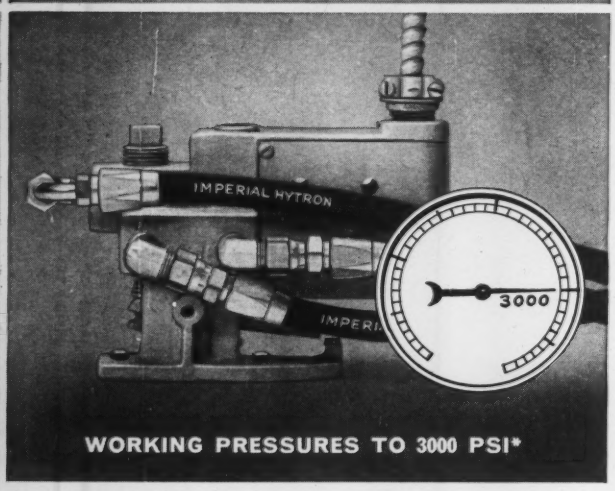
Easy to program. FORTRAN, IBM's scientific computer language is available for the 1620. General Nuclear scientists use a special scientific interpretive program—FIDO—written by the Manager of their Computing Section.

IBM®
DATA PROCESSING

CIRCLE 18 ON READER-SERVICE CARD







No wonder HYTRON® HOSE outperforms wire braid hose . . .

Hytron polyamide-polyester hose takes abuses that make other plastic and wire braid hoses fail. It's tough, durable, lightweight. Has 7 times longer flex impulse life than wire braid. It's versatile. Greater compatibility with mineral or synthetic fluids having a water or phosphate ester base gives Hytron a wider range of uses than other hoses. Available in long lengths, too—to 1000 ft. Some of the hundreds of applications especially suited to Hytron hose include:

Hydraulic lines	Non-conductive (electrical) applications
Hot paint lines	High-lines for electric power
Solvent lines	Fuel and oil lines

High pressure pneumatic and CO_2 lines

***Based on comparative tests with one-wire braid hoses.**

Find out how Hytron Hose can do the job better and save you money. Send for detailed report and test results—Bulletin NEPR-500.

IMPERIAL EASTMAN

Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

Imperial-Eastman Corporation (Canada) Ltd., Barrie, Ontario, Imperial-Eastman, S.A., Apartado Postal 26544, Mexico 13, D.F.

CIRCLE 19 ON READER-SERVICE CARD

EXTRA-TOUGH
AND FLEXIBLE
1. Abrasion-resistant thermoplastic cover
2. Tough polyester reinforcement—no wires to fatigue
3. Clean, nonporous, seamless polyamide inner tube

it's thermoplastic!

- Highly flexible—minimum bend radius is only half that of one-wire braid hose.
- 60% lighter in weight than wire braid hose.
- Smaller O. D. than same size I. D. wire braid hose—reduces assembly bulk, permits use of more couplings in confined areas.
- More resistant to more chemicals at higher temperatures than standard hose. Resists sunlight, mildew, aging.
- Temperature ranges from −40° to 225° F.
- Low diametrical expansion.
- Over 200 times the torsional fatigue life of wire braid.
- Available in long lengths—up to 1000 ft. Sizes ⅛" to ½".

Hytron hose furnished as factory-made assemblies with permanently attached couplings, or with easy-to-install, re-usable couplings in a wide range of sizes and styles.

IMPERIAL — EASTMAN

CIRCLE 19 ON READER-SERVICE CARD

I&CS INQUIRIES

Cermet Thermocouple Sheaths

Australian representative of instrument manufacturers seeks new source of supply for chromium/almina (metal ceramic or cermet) for sheathing thermocouples. A-6190

Crab Meat Processing

Professional engineer in Florida seeks equipment to automate crab meat processing. A-6189

Aerodynamic Smoke Tunnel

Mechanical design engineer in computer department of electric manufacturing company seeks contact with aerodynamic smoke tunnel manufacturers. A-6188

Lab Rotator

Physician seeks device that can rotate a dozen or more stoppered tubes 4" long x ⅜" dia by 90" for five minutes. A-6192

Multi-element Stationary and Portable Oscillographs

Commanding officer of Navy installation seeks multi-element stationary and portable oscillographs for use on electric power utility system. A-6193

Air Flow Nozzles

Professor of Mechanical Engineering at State College seeks nozzles up to 12" throat dia for measuring air flow. A-6194

Current-regulated Power Supply

Design engineer seeks current-regulated (1%) power supply 10 vdc at 5 amps tungsten lamp, continuous duty. A-6195

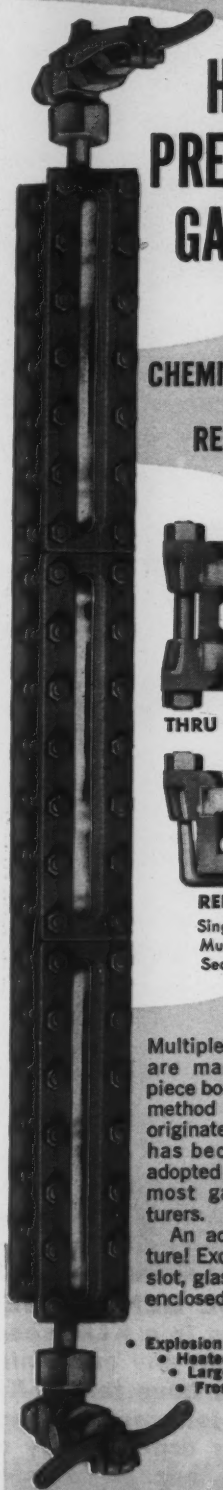
Suspended Load Weighing Equipment

Manager of product development for manufacturer of fused aluminum oxide seeks apparatus to weigh loads while being lifted by hoist. A-6196

Glove-type Integral Temperature Controller

Staff engineer of Research Institute seeks "glove-type integral temperature controller" for maintaining TO-5 or TO-18 component at constant temperature (about 50°C). Temperature stability of ±½ to 1°C satisfactory. A-6197

Strahman



HIGH PRESSURE GAUGES

FOR CHEMICAL PLANTS AND REFINERIES

THRU VISION

REFLEX
Single or Multiple Sections

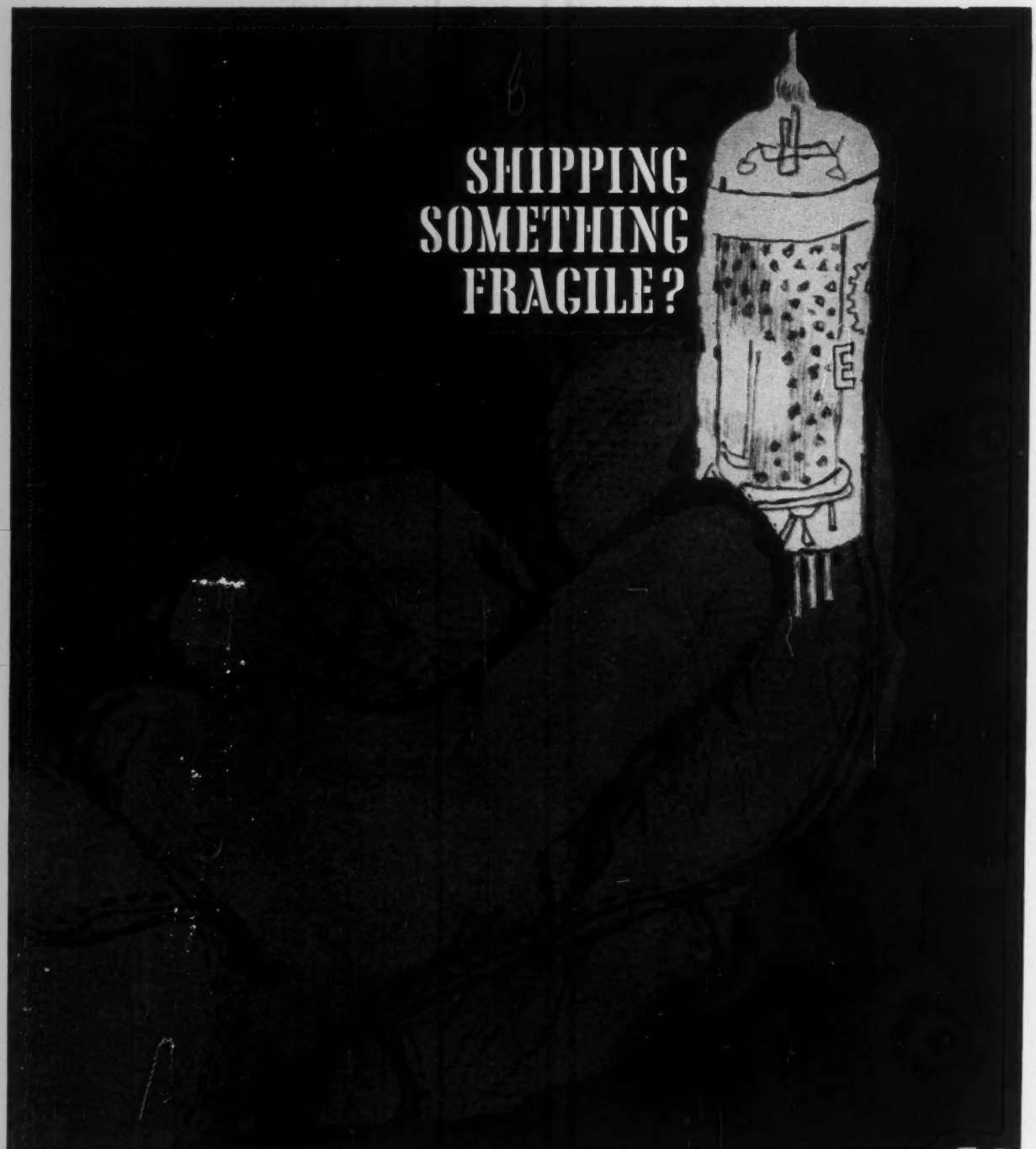
Multiple section gauges are made with a one piece body chamber. This method of construction, originated by Strahman, has become generally adopted as standard by most gauge manufacturers.

An added safety feature! Except for visibility slot, glass is completely enclosed.

- Explosion proof illuminators
- Heated or cooled gauges
- Large Chamber Gauges
- Frost-proof extensions
- Tubular Gauges
- Gauge Cocks

STRAHMAN VALVES INC.
NICOLET AVE., FLORHAM PARK, N. J.

CIRCLE 20 ON READER-SERVICE CARD

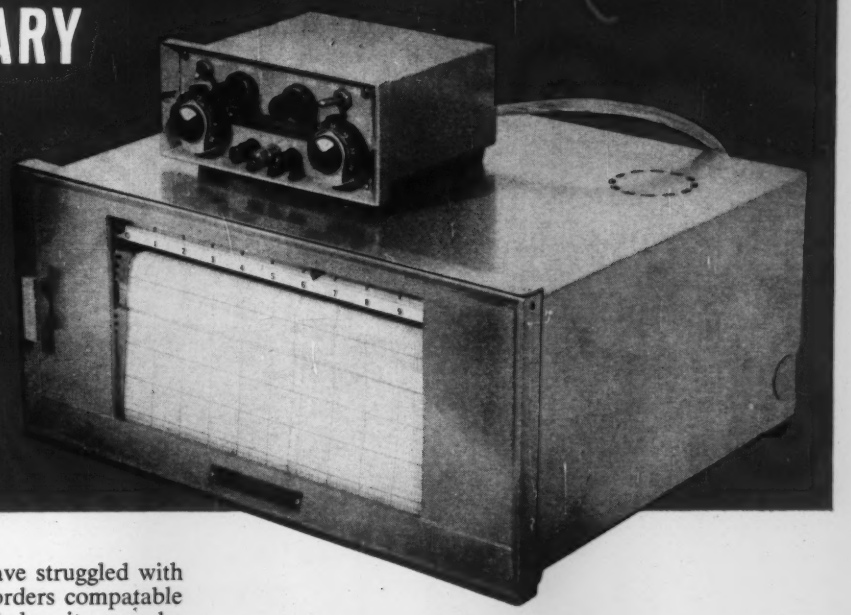


CALL THE GENTLE MEN OF AIR CARGO *Tender treatment of delicate shipments is a KLM specialty. KLM has been flying cargo internationally longer than any other airline... over 42 years, in fact. And all the years of service have taught KLM people the best ways to deliver cargo in a hurry, at low cost... intact. Call your KLM Cargo Representative. He'll send your order to any overseas city. He'll make all the necessary decisions, accept complete responsibility, keep close watch over your shipment till it's delivered. He's the answer man of cargo— the biggest reason why KLM is cargo choice of the world. KLM Royal Dutch Airlines, 609 Fifth Ave., New York, N. Y.*

THE WORLD OVER
KLM
ROYAL DUTCH AIRLINES

CIRCLE 21 ON READER-SERVICE CARD

REVOLUTIONARY NEW CONCEPT IN RECORDING!



For years instrument users have struggled with making their potentiometer recorders compatable with changing input needs. Today it may be necessary to measure temperature, tomorrow pressure. In order to be prepared to meet these changing demands it has been necessary to stock a number of recorders, or spend hours in modifying existing input circuits.

This costly and outmoded instrumentation is no longer necessary! Westronics, Inc. now brings to the industry a totally new *UNIVERSAL RECORDER* featuring panel or table mounted *EXTERNAL PLUG-IN* input modules. Each has in itself a maximum of versatility.

The Standard Universal Recorder is completely self contained: Ready for millivolt or thermocouple recording (changeable by means of *INTERNAL PLUG-IN RANGE CARDS).*

By simply connecting one of the *EXTERNAL INPUT MODULES* to an existing receptacle on the rear of the instrument, its uses are extended to: *ADJUSTABLE SPAN AND ZERO, RESISTANCE BULB CALIBRATION, STRAIN GAGE MEASUREMENT,* and *MANY OTHER USEFUL FUNCTIONS!*

MODERN DESIGN

Everything about the new Westronics Universal Recorder is modern. Nothing old fashioned about this one! Note these features:

- COMPACT DESIGN (Only 8⅝" high)
- ZENER DIODE STANDARDIZATION
- PULL OUT CHASSIS
- PLUG-IN AMPLIFIERS
- BALL POINT PENS (That Really Work!)
- QUICK CHANGE CHART SPEED SELECTOR (No gears to change)

QUALITY

The new Westronics Universal Recorder features a servo system that uses ball bearings throughout. The pen carriage utilizes ball bearing motion on a precision ground track. No troublesome sheet metal parts sliding on rods on this one. Smooth ball bearing floating action is what makes dependable Ball Point inking practical.

VERSATILITY

The new Westronics Universal Recorder is second to none in versatility. Available in 5" and 11" strip chart sizes, single pen, 2 pen and multipoints.

ALL THESE FEATURES AND A COMPETITIVE PRICE TOO!

CALL ON ONE OF WESTRONICS 23 SALES-SERVICE REPRESENTATIVES TO HELP YOU SPECIFY A WESTRONICS UNIVERSAL RECORDER TODAY.

westronics, inc.

TWX FT 8248 U • 3605 McCART STREET • FORT WORTH, TEXAS

CIRCLE 22 ON READER-SERVICE CARD

New Honeywell Series 10/20 Millivoltmeters give you an easier-reading scale, and all the latest features for indicating, controlling and safety cut-off.

NEW HONEYWELL MILLIVOLTMETER LINE

gives wider selection . . . greater accuracy

The newly designed Series 10/20 provides accuracy of ±½%, plus all the latest features in millivoltmeters for indicating, controlling and safety cut-off. Wide selection of ranges and control units makes it easy to match the Series 10/20 to your specific process requirements. Extra-sturdy construction ensures accurate and reliable service even under severe operating conditions.

Here's what you get with the New Series 10/20 Millivoltmeters:

higher accuracy
Accuracy ±½%. High resistance measuring circuit minimizes calibration shifts due to changes in external resistance.

simplified installation
Dual-voltage transformers permit operation from either 115 or 230 volts. Dual tap connections make installation easy.

reads easy, reads right
Large, clear six-inch scale with anti-parallax mirror ensures easy, accurate reading.

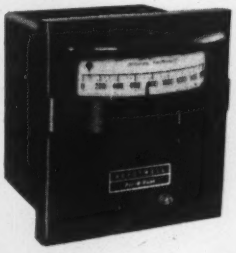
plug-in maintenance
True plug-in design enables you to replace major components in seconds.

high-brightness signal lights
Amber and red lights show at a glance the exact relationship between temperature and set point.

variety of ranges
A wide selection of ranges is available to measure temperatures as low as 325°F and as high as +3400°F within spans as narrow as 400°F and as wide as 3000°F.

thermocouple burnout protection
Process shuts down in event of thermocouple open circuit.

control forms to fit needs
There are 14 different control forms to give you exactly the control action you need: spst; spdt; sp3t with adjustable neutral; *Pyr-O-Vane* for electric on-off, two-position or three-position control; *Protect-O-Vane* for excess temperature cut-off with signalling or shutdown feature; *Pyr-O-Pulse* for pulse-proportioning control; and *Pyr-O-Volt* for current proportioning control.



for economy in less demanding applications . . .

HONEYWELL SERIES 10/10 MILLIVOLTMETERS

Here's a millivoltmeter line that's ideal for those applications where demands are less stringent, and where accuracy requirements are within ±1%. The Series 10/10 provides many of the design and construction features of the 10/20. It's the only economy millivoltmeter line with a full six-inch scale. These units are available in vertical cases only, with Pyr-O-Vane, Protect-O-Vane, and the new anticipatory Pyr-O-Pulse control units.

Get complete technical data and prices on the New Honeywell Series 10/20 Millivoltmeter Line by contacting your local Honeywell field engineer. Be sure to ask him about the economy Series 10/10. Minneapolis-Honeywell, 21 Penn Street, Fall River, Massachusetts. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

H First in Control

HONEYWELL INTERNATIONAL Sales and Service offices in principal cities of the world.
Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

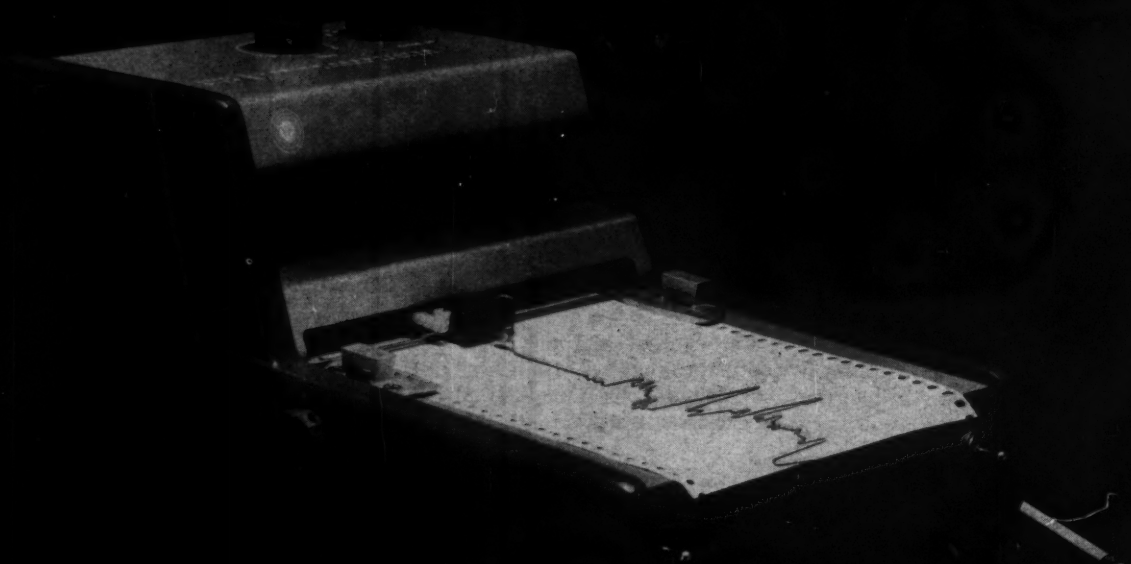
CIRCLE 23 ON READER-SERVICE CARD

ANNOUNCING THE ALL NEW VARIAN G-14 GRAPHIC RECORDER

1 MV SPAN...PLUS 10 MV, 100 MV, 1 VOLT SPANS INSTANTLY SELECTABLE • ALL TRANSISTOR CIRCUITRY • PEN SPEED 0.6 SECONDS FULL SCALE • ZENER DIODE REFERENCE • 0.5% ACCURACY AT 10 MV • FULL SCALE ZERO PLUS SUPPRESSION

The all new G-14 is carefully designed to provide the optimum combination of performance, operator convenience, versatility, size and price. Solid state circuitry, high negative amplifier feedback, rugged construction, quality components and null-balance potentiometer operation provide stable, accurate and reliable recording. Complete specifications available from the Instrument Division.

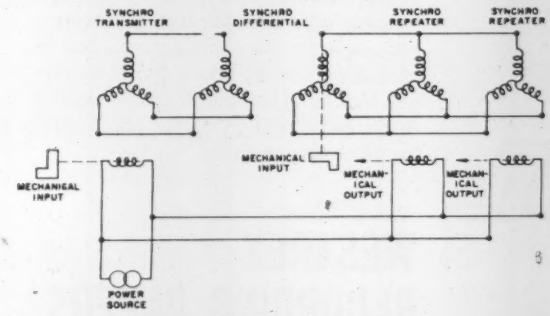
VARIAN associates
PALO ALTO 27 CALIFORNIA



BRIEFS

Synchros for Servo Systems

The term "synchro" is a generic one covering a range of AC electromechanical devices which are used in data transmission and computing systems. A synchro provides mechanical indication of its shaft position as the result



of an electrical input or an electrical output which represents some function of the angular displacement of its shaft. Such components are basically variable transformers. As the rotor of a synchro rotates it couples and decouples one or more windings of the stator. Torque-type synchros are commonly designated as transmitters (TX), differentials (TDX), and receivers (TR), and comprise the simplest system for driving dials and pointers directly without further amplification . . . (*From new 62-page "Technical Information for the Engineer, No. 1," Kearfott Div., General Precision, Inc., Little Falls, N. J.*)

FOR THIS LITERATURE CIRCLE 191 ON READER-SERVICE CARD

Industrial Relays

The relays in this catalog are designated as standard relays because they are either stocked by local distributor for immediate delivery or tooled for production . . . The GHA and GHP Relays are identical except for enclosure

CONTACT ARRANGEMENTS

DESIGNATION		SYMBOL	
CONVENTIONAL	NARM*	ELECTRONIC	ELECTRICAL
Make SPSTNO	1A		
Break SPSTNC	1B		
Break, make (transfer) SPDT	1C		

and mounting. GHA (1C and 2C) have UL approval. Specifications (include)—Contact arrangement: 1C-(SPDT), 2C(DPDT) and 3C(3PDT), Contact rating: 5 amps resistive, 2 amps inductive at 115 vac or 2.65 vdc, Contact material: fine silver, gold flashed . . . Nominal Coil Power Required—DC Relays: 1 to 2 watts nominal, AC Relays: 2 to 3 volt-amperes nominal . . . (*From new 32-page catalog, Elgin Advance Relays, Electronics Div., of Elgin National Watch Co., 2435 North Naomi St., Burbank, Calif.*)

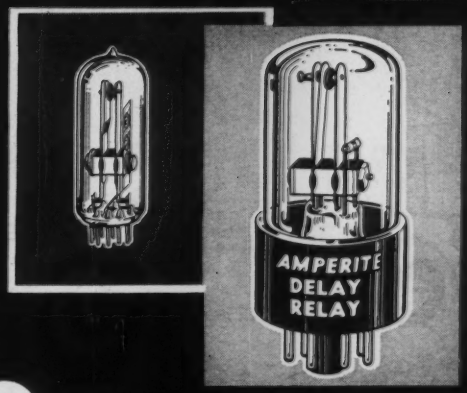
(*Continued on page* 2197)

FOR THIS LITERATURE CIRCLE 192 ON READER-SERVICE CARD

← **CIRCLE 24 ON READER-SERVICE CARD**

AMPERITE

Thermostatic DELAY RELAYS



Only a glass seal offers true hermetic sealing . . assuring maximum stability and life!

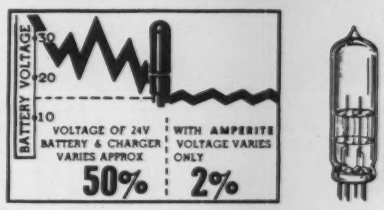
Delays: 2 to 180 seconds . . . Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being **hermetically sealed,** they are not affected by altitude, moisture, or climate changes . . . **SPST only**—normally open or normally closed . . . Compensated for ambient temperature changes from —55° to +80° C. . . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE

BALLAST REGULATORS



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

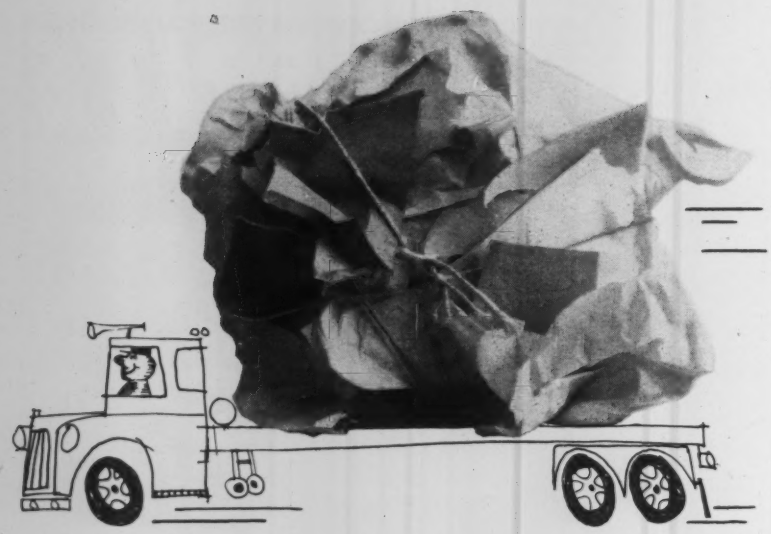
Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

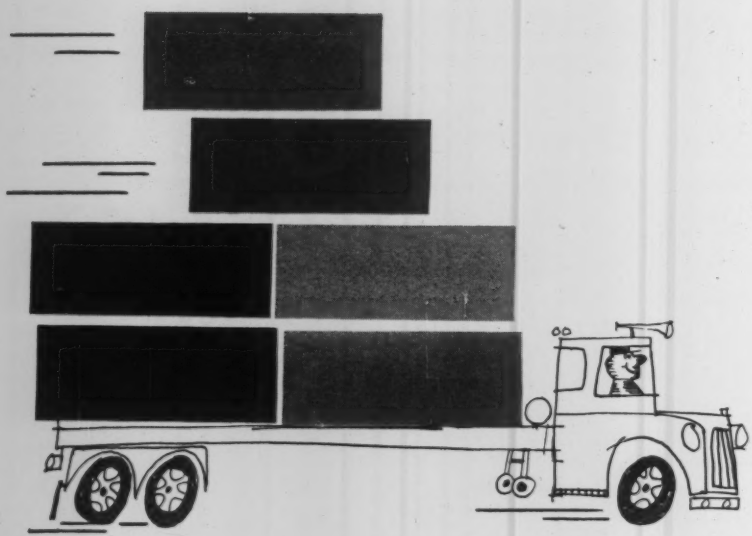
CIRCLE 25 ON READER-SERVICE CARD



TRUCKLOAD OF RECORDING PAPER PROBLEMS?

Solve them with these Westrex electrosensitive papers. Ready to use. Dry and unaffected by heat, light, radiation, or unusual storage conditions. No special handling before or after use. Make clear, dry, legible, permanent copies. All sizes for single, continuous, and reproducible (mimeo, offset, hecto) copy recording. For single and multi-stylus and fixed or oscillating pen recorders. For business and industrial communications, weather maps, sea condition charts, and a variety of instrumentation data.

WESTREX RECORDING PAPERS FOR FACSIMILE, CHART, AND DATA RECORDERS



TIMEFAX NDA® Single copy paper for current-carrying stylus recorders grounded on recording side. White top. For AC use, but also marks with DC.

TIMEFAX A® Similar to above but for making duplicate copies by gelatin hectograph process.

FILM BASE NDA Like **TIMEFAX NDA.** High dimensional stability. Makes reverse Diazo (Ozalid) copies.

TIMEMARK® Single copy paper for DC marking circuits grounded on underside. New white top. Smooth surface. Low voltage and stylus pressure requirements. Also marks with AC.

STENAFAX® Stencil for duplicating by mimeograph process.

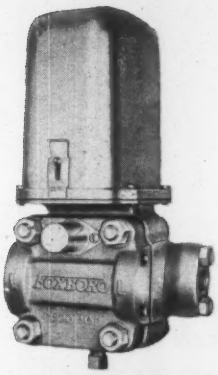
PLANOFAX® Offset master for Multilith reproduction.

Westrex also has heat-sensitive and pressure-sensitive recording papers. All are made by the world's largest developer and manufacturer of facsimile communications equipment and accessories. Write us for complete details.

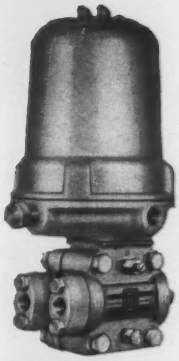
Westrex Company

A DIVISION OF LITTON SYSTEMS, INC.
540 West 58th St., New York 19, New York

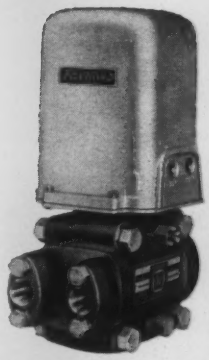
CIRCLE 81 ON READER-SERVICE CARD



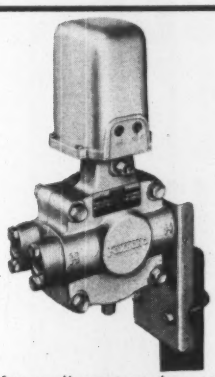
T13AA — for absolute pressure of dryers, columns, evaporators.



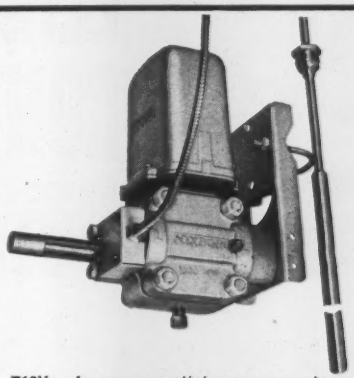
T613 — for long distance measurement of flow, level, pressure drop. All electronic transmission.



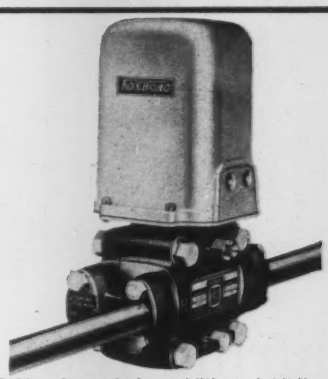
T13A — for metering practically all process flows, densities, liquid level.



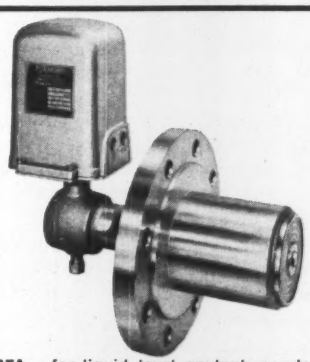
T15A — for small pressure drop across filters, heaters, orifices; for small liquid level heights, density measurement.



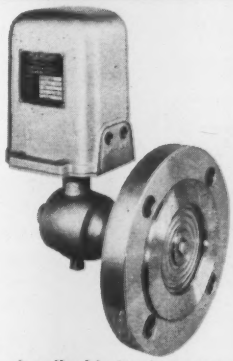
T13V — for vapor partial pressures, steam stripping or column control.



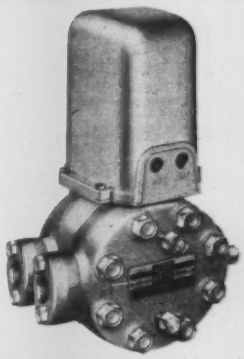
T13A — for metering additives, inhibitors, reactants, product gas or liquid — .003 to 10 gpm.



T13FA — for liquid level on tank nozzles without pocketing of process fluids: mounts flush with tank interior.



T13FA — for liquid level measurement: mounts direct on nozzle or tank flange.



T13HA — for flow, level, interfaces at pressures up to 6000 psi.

these Foxboro d/p Cell* Transmitters are related ...in design – in accuracy – in savings for you

These are the transmitters every company needs, to know and control its processes. To keep track of purchases, production and sale of fluids. To maintain close control of costs, quality, and safety.

And since each uses the same basic Foxboro d/p Cell, you get all the advantages of standardization. Universal calibration techniques—simplified training of personnel—reduced stocks of component parts. Plus the highest sustained accuracy of measurement and transmission under the most punishing operating conditions.

Pneumatic or electronic systems, new plant or modernization, why not standardize on industry's standard — the Foxboro d/p Cell Transmitter. Write today for descriptive literature. The Foxboro Company, 4612 Norfolk St., Foxboro, Mass.

*Reg. U. S. Pat. Off.

FOXBORO

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CIRCLE 27 ON READER-SERVICE CARD

M LINE FLEXIBILITY ELIMINATES CONTROL DOWN-TIME

during routine checks or maintenance

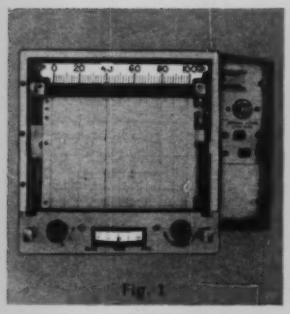
Fig. 1

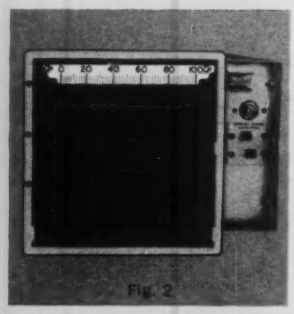
Fig. 2

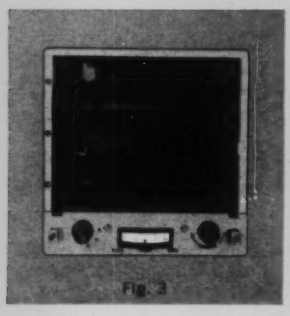
Fig. 3

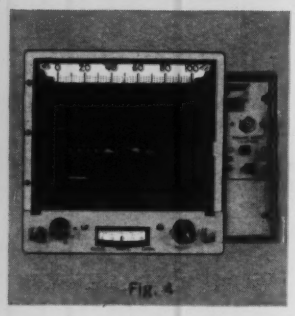
Fig. 4

With the M-Line Control System, you maintain continuous control of process variables—*even with major control components removed.*

Designed with independent control circuitry and unitized, plug-in components, the M-Line System needs no "time-out" from control for servicing—assures that the process can be kept at optimum production, at all times.

FOR EXAMPLE: With the set-point station, controller, and auto-manual station in place (Fig. 1), control can be automatic or manual as desired.

Pull out the auto-manual station (Fig. 2)—and the process automatically goes on *automatic* control. Or pull out the set-point station and/or the controller as in Fig. 3—and the process can still be regulated by manual control, through the auto-manual station.

Pull out the Speedomax M Recorder (or M-Line Indicator) at *any* time as in Fig. 4—control is completely independent and unaffected.

When you require this kind of flexibility in competitively-priced instrumentation it'll pay you to investigate the sound investment M-Line provides. Evaluate it yourself—you'll find M-Line the best buy in electronic process control.

For more information on this exceptional line, call your nearest L&N Field Office, or write to 4955 Stenton Ave., Philadelphia 44, Penna.

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LEEDS & NORTHRUP
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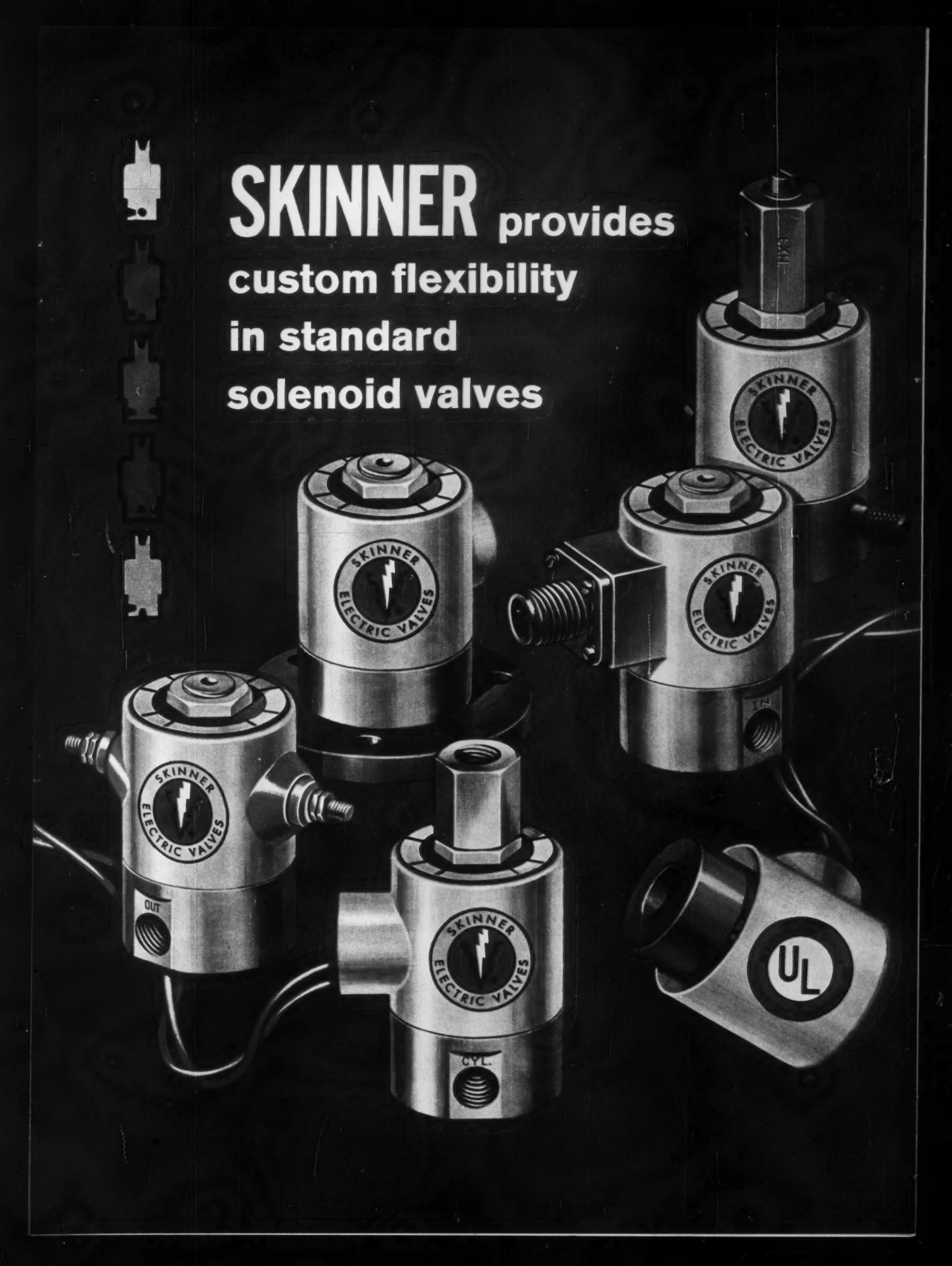
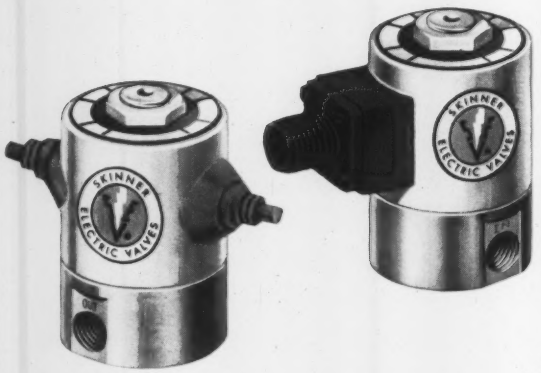
CIRCLE 29 ON READER-SERVICE CARD →


SKINNER provides
custom flexibility
in standard
solenoid valves
SKINNER
ELECTRIC VALVES
IN
OUT
CYL.
UL

Versatile, top quality V5, X5 line offers wide range of options

Skinner's two-way and three-way V5, X5 series of solenoid valves has earned the description—"The Universal Line." With more than 100,000 variations possible, V5, X5 valves are available for every conceivable application. And top quality is emphasized with bubbletight sealing, and stainless steel body, plunger and sleeve assembly. Precision machining, unique welding techniques, specially designed and developed machinery and manufacturing methods are all used by Skinner to produce the best valves made. These valves are small, yet handle operating pressures as high as 3000 psi. They accommodate all media that do not corrode stainless steel. And no other solenoid valves offer so many optional features. Check the following options.



FLOW CONTROL

Precise, accurate control of media flow is possible with all Skinner V5, X5 valves. Both two-way and three-way valves are available with adjustable flow in the main stream, and with manual override. Two-way valves are also available with adjustable bypass. Exhaust flow can be controlled in three-way valves.

ELECTRICAL HOUSINGS

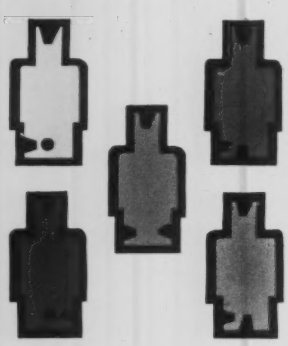
Skinner offers an electrical housing for any application. Some of the most common are:

- standard ½" NPT conduit
- grommet outlet
- single or double automotive terminals
- JIC housings with integral junction box
- AN connector for military applications
- strain relief connector for quick disconnect

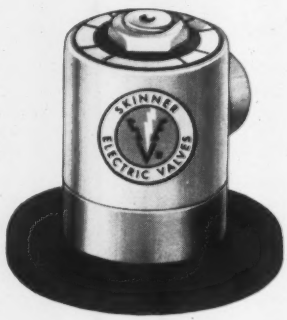
All housings are steel, plated for wear and appearance, and can be rotated 360° for easy installation.

PORTING

Restrictions of installation or application, and mounting are minimized because Skinner provides a wide variety of port location options. V5, X5 valves are available with ports at right or left angles, on bottom, top, and sides for virtually all combinations of flow.



MOUNTING



Skinner V5, X5 valves are provided with tapped holes for normal mounting, with mounting brackets for panel or other surface, or with flange for direct mounting without threaded pipe connections.

The Skinner V5, X5 series of two-way and three-way solenoid valves provides top quality design with orifices from 1/32" to 3/8" diameter, normally open, normally closed, dual purpose, directional control and multi-purpose, in standard and explosion-proof construction. Also included in this line is a three-way quick-exhaust type which is designed with an additional port to exhaust cylinders 4 times faster than standard types.

COILS

Skinner V5, X5 valves are available with coils of many types for most DC and AC voltages at 25, 50 and 60 cycle frequencies. Whether your requirements are for continuous or intermittent performance, in tropical, high moisture or high temperature environments, or for dual voltage, Skinner UL approved coils are available with leads of several types and lengths.

• • •

Typical applications—machine tools, cylinder control, instrumentation and automation of all kinds, laundry equipment, aircraft and missiles, etc. For catalogs and complete information contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed internationally.

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THE CREST OF QUALITY

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION,
THE SKINNER CHUCK COMPANY • NEW BRITAIN, CONNECTICUT, U.S.A.

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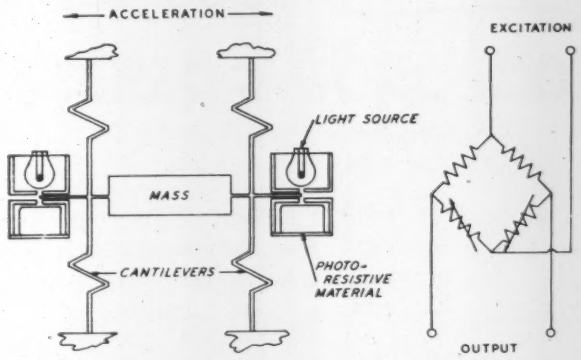
Photo-Transducer Accelerometer

The photo transducer utilizes a light source, a photo-resistive solid-state element, and a mechanical shutter which controls the light-exposed area of the photo-resistive element. The shutter exhibits a linear or angular dis-



placement proportional to acceleration, force, pressure, temperature, etc. produced by mass-cantilever, beam-deflection or diaphragm-displacement.

The illustration schematizes the operating principle as applied to a linear accelerometer. The seismic mass is suspended by two cantilevers. It has two extension shutters. The 'quantity' of light determines the resistance of the material. Changes in light intensity over a relatively wide range do not affect the resistance versus area-exposed relation.

The light source is extremely small and capable of sustaining static or vibratory accelerations in the order of several hundred g's. Its life is in excess of 60,000 hours. The photo transducer operates with the light source energized at 80% of rated power, thus extending its life beyond a service period of ten years.

Transducers operating on this principle may be excited with voltages as high as +100 VDC and can provide output voltages in the order of 180v. Ordinarily, the output signal is specified as ±2.5v or 0-5v, due to long standing requirements established by typical voltage controlled sub-carrier oscillators used in telemetry systems.

Almost any other existing type of transducer, potentiometric, bonded or unbonded strain gage, piezoelectric, vibrating wire, etc., requires that energy be transformed from the force-summing member to the electrical sensing element, and thus presents serious sensitivity limitations. For small magnitudes of the physical stimulus, this energy transfer also contributes to the total inaccuracies of the measurement obtained . . . (*From Technical Bulletin "The Photo Transducer—A General Description," Data Sensors Inc.,* 13112 *Crenshaw Blvd., Gardena, Calif.*)

FOR THIS LITERATURE CIRCLE 193 ON READER-SERVICE CARD

FOR YOUR LIBRARY

100 Electronic Circuits—Vol. 1 **$2.00**

by M. H. Aronson and C. F. Kezer . . . covers amplifiers, oscillators, pulse circuits, phase shifters, etc. Complete with all circuit component values and response specifications. Paper, 180 pages, 1957.

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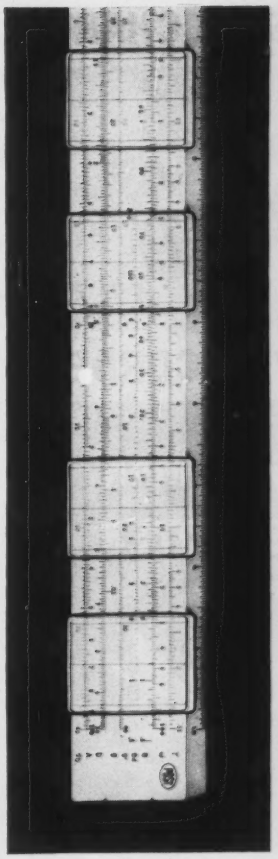

Solve frequency response problems at slide rule speeds!

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Especially designed to obtain frequency responses of physical systems where transfer functions can be converted into real linear and exponential factors. The Control Engineering Slide Rule can also be used to compute magnitude ratios and phase shift angles for physical systems subjected to sinusoidal inputs. A remarkable and economical tool for solving control engineering, mechanical or electrical engineering problems!

Exclusive with POST, the Control Engineering Slide Rule has specialized scales not found on any conventional slide rule. Four cursors (with 3 hairlines each) store information directly on the rule . . . you make extended calculations without stopping to write down results of many individual calculations.

Constructed of laminated bamboo with graduations accurately machine-cut on white plastic face. Scales for direct conversion from decibels to actual magnitude, and from angular frequency to frequency (cycles per unit time) or period (time per cycle), are also provided. The POST Control Engineering rule also has the standard C, CI, D, and A scales for multiplication, division, squares and square roots.

Any ratio, as a number of the A scale, may be converted directly to decibels by reading the number opposite the db scale. Scales are color-coded to make them quicker and easier to co-ordinate without error. Furnished with genuine leather case, instruction manual and special Lucite attachment for computing frequency response of the quadratic factor. Length: 11¾" overall. No. 1490 . . . $24.00.

For further information, write FREDERICK POST COMPANY, 3638 North Avondale Avenue, Chicago 18, Illinois.

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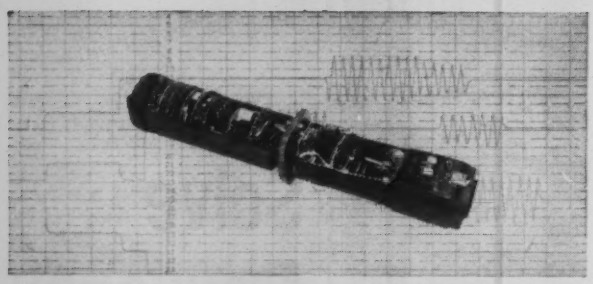
←CIRCLE 29 ON READER-SERVICE CARD

THANKS TO BRISTOL CHARTS



AND HATHAWAY RECORDER

A compact airborne recorder assembly made by Hathaway Instrument Division of Hamilton Watch Company, Denver, Colorado, is used in simulated firings to train pilots in use of the Falcon air-to-air missile.

This rugged instrument records firing data on photo oscillographic paper, preprinted with accurate amplitude and reference lines by The Bristol Company.

Bristol's chart service developed the new process which permits accurate (±0.005") printing through photo sensitive emulsions and produces preprinted photo charts for oscillograph use.

This is just one example of Bristol's ability to design a chart to meet your special instrument requirements. On specially treated, coated or laminated stock, if required. With special punchings or printing to any desired mathematical law.

Your instrument is no better than the chart it records on. So for more information on Bristol's long experience in chart engineering and accurate, economical production methods, write: The Bristol Company, 154 Bristol Road, Waterbury, Conn. 9.23

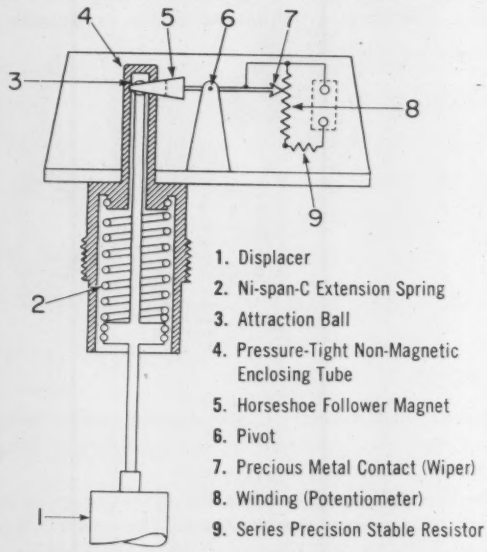
BRISTOL ...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 31 ON READER-SERVICE CARD

Resistance Level Detectors

The Model 369 Precision Resistance Level Detector used to measure liquid level and convert it directly to an electrical resistance . . . employs a unique frictionless magnetic coupling to transmit motion from level change

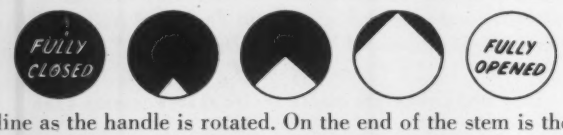


in the vessel to contact wiper movement on the potentiometer winding inside the instrument housing. Primary level change is sensed by a range displacer suspended in the liquid by means of a precision Ni-span-C extension spring. As the liquid level rises or falls the effective weight of the displacer changes, causing the spring to extend more or less. A magnet-attracting ball is rigidly attached to the displacer by a stem and remains centered inside a nonmagnetic pressure tight tube due to the downward weight of the displacer. A pivoted horseshoe magnet on the outside of the enclosing tube follows the attraction ball and transmits movement to the contact wiper . . . (*From new 4-page Publication 3062, Thomas A. Edison Industries, Instrument Div., West Orange, N. J.*)

FOR THIS LITERATURE CIRCLE 194 ON READER-SERVICE CARD

Straight-Flow Control Valve

The Arrowflo Straight-Flow Control Valve accomplishes its flow regulation by a new and unique method. The stem is located at a 45° angle to the flow. The stem does not rotate, being keyed on the bonnet, but rises in a straight



line as the handle is rotated. On the end of the stem is the tip which has a V-shaped groove milled in it at a 45° angle . . . The flow passes through the groove parallel to the apex. In this manner, the flow does not appreciably deviate from a straight line at any one point, resulting in almost zero fluid friction and zero turbulence . . . (*From new 4-page bulletin, General-American Valve Co., 413 Poinsettia St., P. O. Box 444, Corona del Mar, Calif.*)

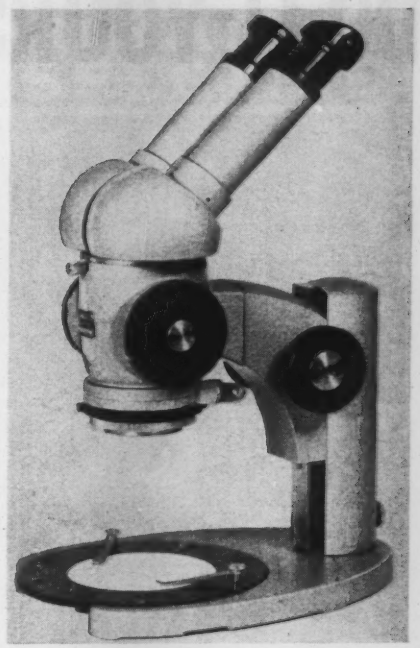
FOR THIS LITERATURE CIRCLE 195 ON READER-SERVICE CARD

(*Continued on page* 2201)

New CARL ZEISS

STEREO-MICROSCOPE II

MADE IN WEST GERMANY



This sturdy, compact instrument produces an image of outstanding plasticity—erect, unreversed, and uniformly sharp over the entire field of view. It is easy on the eyes, even under prolonged observation.

Offers novel, rapid change of magnification from 2.5x to 100x, with wide-angle oculars.

Affords a large working distance—3-1/8 inches—with diameter of object field up to 50mm. Beyond 100x magnification, a 2x supplementary objective is available, having a working distance of 1-1/8".

Write for literature which gives complete details

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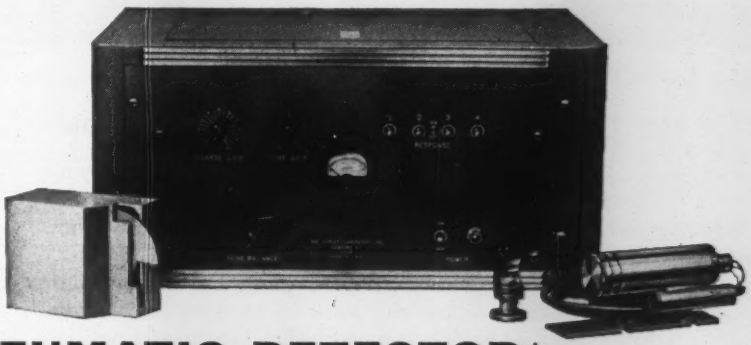
CIRCLE 32 ON READER-SERVICE CARD

A Superior Detector for Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR*

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infra-red spectroscopy are:

1. An effective sensitive area 3/32" in diameter.
2. Sensitivity of 6 x 10^{-11} watts RMS-ENI when used with "chopped beam" method and with recording time constant of 1.6 second.
3. Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the microwave region.
4. Improved, drift-free. A. C. operated amplifier with step gain controls and four response periods.

Write for EPLAB Bulletin No. 10

*Fundamental and experimental aspects of this detector are discussed in the following publications: Rev. Sci. Inst. *18*, 347 and 357 ('47); ibid., *20*, 816 ('49); Proc. IRE *40*, 1161 ('52).

278-8

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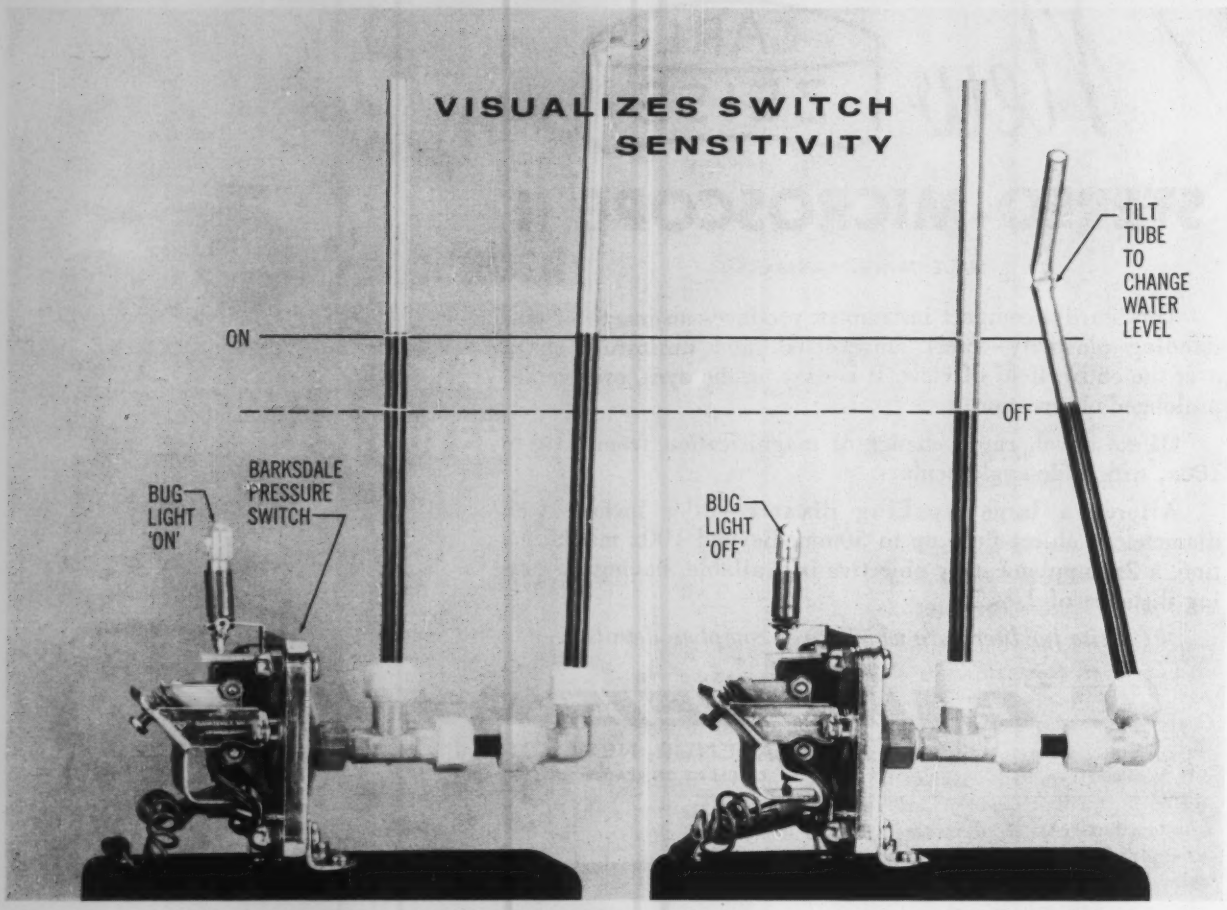
DO-IT-YOURSELF DEMONSTRATION



Pressure switch actuates and reactuates on less than 1" water; revises control accuracy standards

A demonstration kit like that pictured will be placed on your desk at your request so that you may see for yourself with what amazing accuracy one inch of water actuates and re-actuates new-design Barksdale pressure switches. Proof (test) pressure of switch pictured is 10 psi (about 23 feet of water) and maximum adjustable range is 3 psi (6 feet of water). The demonstrator works this way: Actuation and re-actuation points are identified on the vertical tube by metal rings. Fig. 1 shows a stripped switch in actuated position with bug light on. When tube is lowered (Fig. 2) the water level in the right hand tube drops. The bug light goes out when the switch reaches the re-actuation point. The accepted standard of accuracy in diaphragm pressure switches is $\pm 1\%$. Barksdale switches are guaranteed for $\pm \frac{1}{2}\%$ set and re-set accuracy. Standard models with adjustable ranges to 400 psi and test pressures to 500 psi are available.

Erector set design offers performance and cost advantages

Barksdale pressure switches embody the specification improvements requested by representatives of varied industries who were consulted before designing was begun. Employment of the erector set construction principle allows wide choice in specifications that approximates a custom made switch and permits use of cost-cutting mass production methods that reduce prices as much as 25%. The following points are important: (1) Diaphragm capsules may be removed without disturbing switch wiring. (2) Because of erector set design, switches may be ordered to fit appropriate application. Addition of a switching element to the basic diaphragm unit makes a stripped switch for use in a common cabinet. Sealed housings (standard, terminal block, or explosion proof) may be specified as required. (3) Standard pressure connection is ¼" npt female pipe fitting; ½" fittings for mounting directly on ½" pipe are available. (4) Single setting or dual control switching elements. (5) Servicing instructions are on the inside of a tamper proof cover to allow for painting of unit. (6) Pot-table electric outlets on explosion-proof housings; external adjustment may be made without breaking the circuit.

Demonstration on request

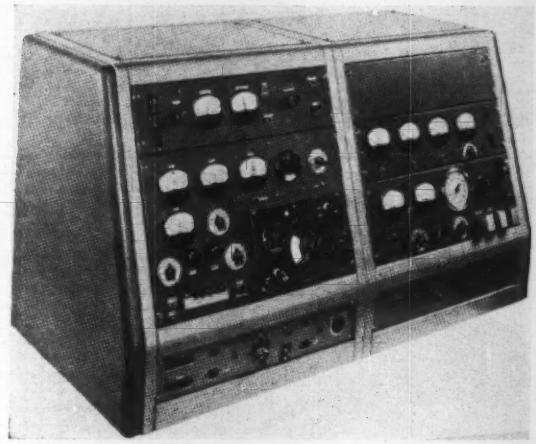
Ask for your do-it-yourself demonstration (of course, you will not be obligated in any way) and a copy of the new Barksdale pressure switch Handbook and Catalog 61-62.

Call your Barksdale representative or write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California.

CIRCLE 34 ON READER-SERVICE CARD

Test Console

The Test and Maintenance Console for ElectriK Tel-O-Set instruments is a complete, self-contained unit comprised of four sections. One section is for use with recorders and indicators; another, for transmitters and

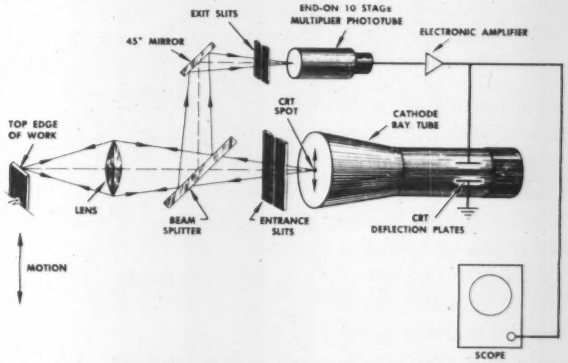


transducers; a third, for oscillators; and a fourth, for controllers. Each section is complete in itself so that all sections, or any combination of individual sections can be used simultaneously . . . Specifications (include)—Meters: 2% of full scale reading. Repeatability ¼ of 1%. Portable Potentiometers: ¼ of 1%. Pressure Gauge: ½ of 1% . . . (*From new Spec SS506-2, Minneapolis-Honeywell Regulator Co., Special Systems Div., Pottstown, Pa.*)

FOR THIS LITERATURE CIRCLE 196 ON READER-SERVICE CARD

Displacement and Vibration

Model 701 focuses a spot of light on the work. A photocell servo system causes this spot to follow the motion of the work. The output presents an exact waveform of the motion . . . Light from the CRT spot passes through the

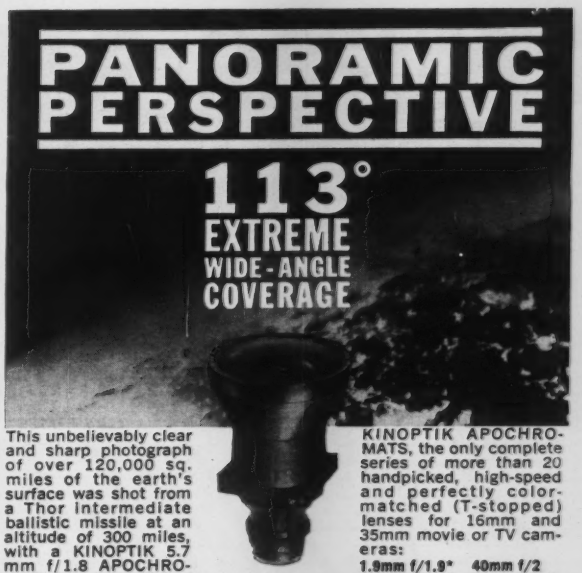


beam splitter and is focussed by a lens on the work. The servo drives the projected spot until it reaches an edge where it locks on. This servo keeps the spot riding the edge with 50% of the spot diameter above the edge and 50% below . . .

Hence the spot locks onto the top edge of the work and follows it. The output waveform shown on the scope is an exact duplicate of the work's motion . . . (*From new 24-page bulletin, Optron Corp., 335 S. Salinas St., Santa Barbara, Calif.*)

FOR THIS LITERATURE CIRCLE 197 ON READER-SERVICE CARD

(*Continued on page* 2204)



This unbelievably clear and sharp photograph of over 120,000 sq. miles of the earth's surface was shot from a Thor intermediate ballistic missile at an altitude of 300 miles, with a KINOPTIK 5.7 mm f/1.8 APOCHROMAT. Free from distortion and with an unsurpassed degree of clarity, definition and contrast, this extraordinary picture exemplifies the outstanding wide-angle coverage (113°) of this unique lens.

KINOPTIK 5.7mm f/1.8 APOCHROMAT

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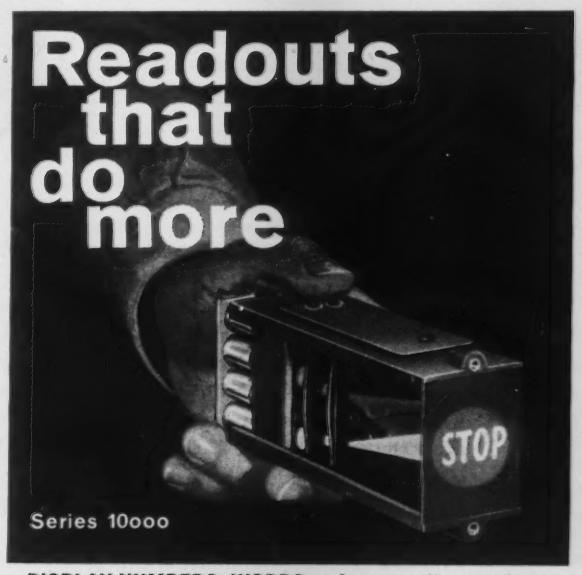
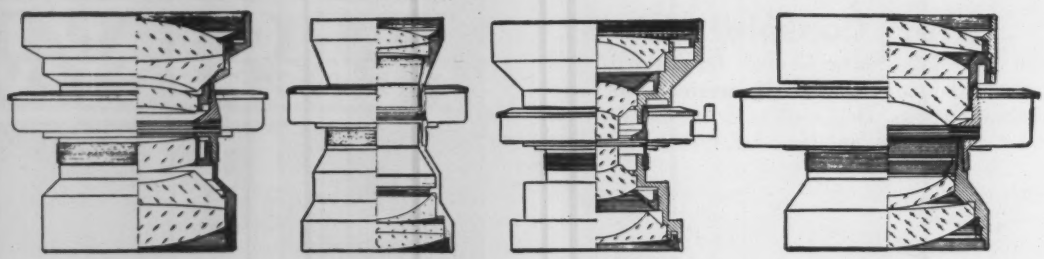
CIRCLE 35 ON READER-SERVICE CARD



DISPLAY NUMBERS, WORDS, COLOR, AND SYMBOLS! employing all the above mentioned features plus a large one inch character size. Ideal for computers, electrical and electronic test equipment, control systems, and annunciation boards. Price complete from $18.00. Write today for complete detailed specifications and quantity prices.

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
5528 Vineland Avenue, North Hollywood, California

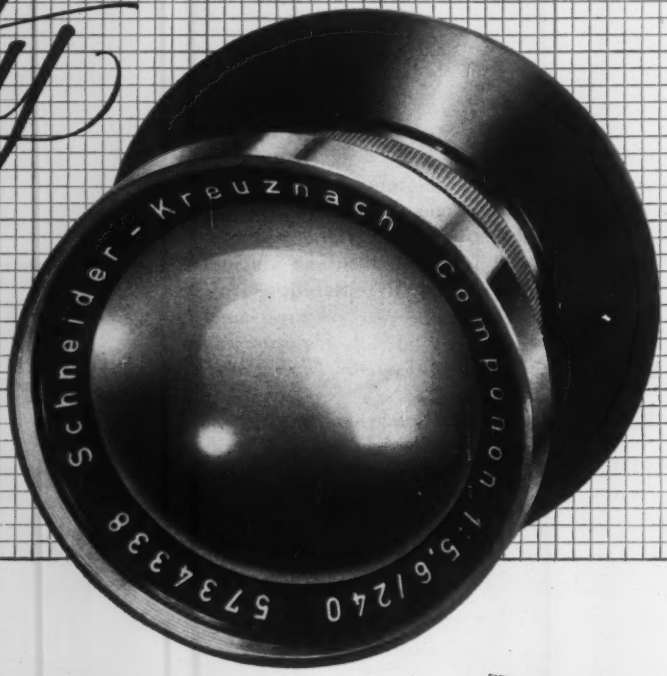
CIRCLE 36 ON READER-SERVICE CARD



SYMMAR TELE-ARTON SUPER-ANGULON XENOTAR

For those with problems involving

Quality Optics



Whether your lens problem involves simple reproduction, or complex optical and electronic devices, it will pay you to check first with Schneider . . . world's leader in quality optics. For the Schneider line, *the world's most extensive*, includes close to 300 different lens types. More than likely, it includes the exact lens you require . . . or certainly one which can be modified to exactly meet your specifications. All are of highest quality available . . . the most modern electronically computed designs (including air spacing) . . . rare earth glasses with all surfaces coated. Yet, these lenses are available at realistic prices . . . another practical reason for you to investigate Schneider. Specification sheets are available giving dimensions, optical characteristics, nodal points, back focus, spectral transmission and relative illumination curves, etc. Literature on request.

Free literature
Literature illustrating and describing many of the Schneider lens types available from stock will gladly be sent on request.

Schneider LENSES... *Classics of Optical Precision*

U.S. Distributor: **BURLEIGH BROOKS, Inc. • 420 Grand Avenue, Englewood, N. J.**

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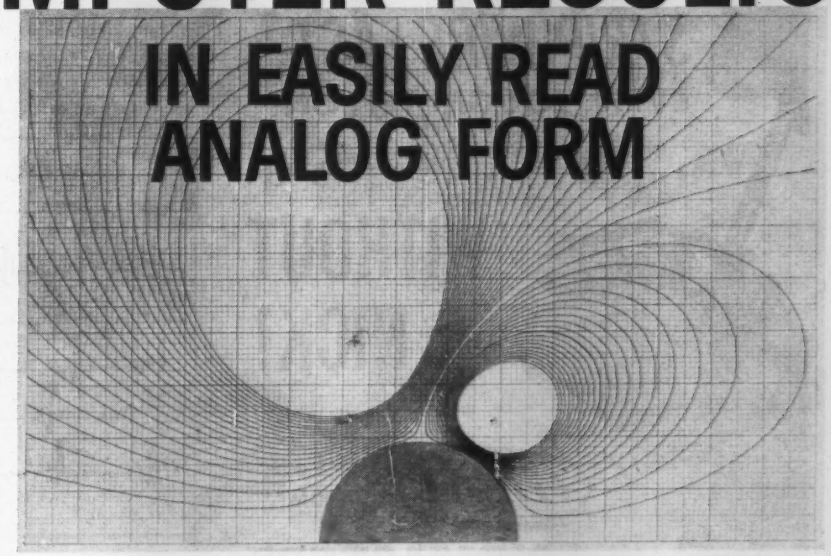
CIRCLE 37 ON READER-SERVICE CARD

PLOT COMPUTER RESULTS IN EASILY READ ANALOG FORM



With Dymec Data Reduction Systems

You can make X-Y or strip-chart recordings from digital data at rates of up to 100 conversions per second with Dymec digital-to-analog conversion techniques. Data recorded at computer speeds on magnetic tape, punched cards or punched tape can be automatically plotted at slower speeds for visual examination and analysis. Additional data can be entered manually with an auxiliary keyboard.

Two moderately priced Dymec Data Reduction Systems are available. One extracts data from magnetic tape; the other is used with punched cards, punched tape or typewritten records. These systems include three types of digital-to-analog converters which are also available separately or as building blocks for custom designed data reduction systems.

DY-6575, A complete system, magnetic tape to X-Y recording

You can increase the efficiency of your high-cost computer with the DY-6575 Magnetic Tape Plotting System. Tape written at 75 inches per second on the computer is read at 3 inches per second for recording. The Dymec system makes 100 conversions/second from digital data on magnetic tape for continuous plotting on a Moseley Autograf Recorder. Accepts binary or BCD inputs, includes search mode and visual display for check-out or calibration. Overall accuracy of plotting system, ±0.2% of full scale. Complete system about $29,750.00.

DY-6242, A complete system, punched cards, punched tape or keyboard to X-Y recording

Plotting speeds of 50 points per minute with punched cards and 80 points per minute with punched tape are yours with the DY-6242 Plotting System, which also is supplied with a 10-key serial entry keyboard for recording tabular data. Overall accuracy of plotting system, ±0.2% of full scale. The Dymec system consists of a digital-to-analog converter, a tape reader and a Moseley Autograf Recorder with character printer. Complete system about $8,700.00.

Three digital-to-analog conversion building blocks

Dymec Model 2742 Digital Data Translator accepts data from IBM cards, perforated paper tape or a serial keyboard and converts for recording up to four decades of data plus a sign for each axis. The transistorized instrument provides a front-panel display for monitoring translator contents, plus controls for calibration, single cycle or automatic operation. D/A conversion accuracy, 0.1%. Price, including manual keyboard, about $4,500.00.

Dymec Model 2743 Series Digital/Analog Converters accept binary, binary-coded-decimal or decimal data for conversion to analog voltages. Up to four channels in one unit. Each can process up to 12 bits of binary, up to 4 decades BCD or decimal data. Price about $3,800.00.

Dymec Model 2744 Series Magnetic Tape Units include tape control unit and tape converters for recording binary and binary-coded-decimal data. The control unit, Model 2744A, accepts data from tape and provides an output to drive one of the converters, Model 2744B for binary data and Model 2744C for BCD data. Price, about $14,700.00, including 2744B or 2744C Converters.

Data subject to change without notice. Prices f.o.b. factory.

Call your Dymec/Hewlett-Packard representative or write direct for information on Dymec digital-to-analog conversion capabilities.

DYMEC

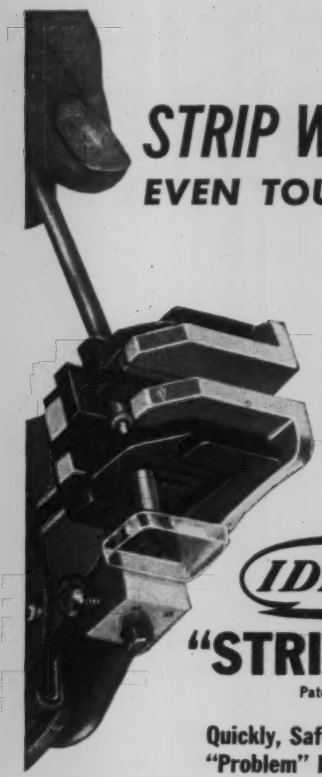
A division of HEWLETT-PACKARD COMPANY

DEPT. S-12, 395 PAGE MILL ROAD, PALO ALTO, CALIFORNIA • DAvenport 6-1755 • Area Code 415

TWX-117-U

7276

CIRCLE 38 ON READER-SERVICE CARD



STRIP WIRE FAST--
EVEN TOUGH TEFLON*
WITHOUT A NICK!

IDEAL CUSTOM
"STRIPMASTER"
Patented, No. 2,523,936

Quickly, Safely Removes "Problem" Insulation from Wire

Now strip the toughest insulation from any wire with just a gentle, harmless squeeze. With Ideal Custom Stripmaster, matched sets of counterbored blades—*precision drilled on watchmaker's equipment to fit wire sizes exactly* are designed to ride on cut insulation, and eliminate wire nicking and scraping. Firm grip of jaws prevents insulation damage. Wire is stripped absolutely clean up to a full 7/8".

Optional transparent wire stop quickly adjusts so that you strip off the exact amount of insulation you want every time. Perfect for fast, accurate production line stripping.

Custom Stripmasters come in three models for 10 to 14, 16 to 26, or 26 to 30 wire gauges.

SOLD THROUGH AMERICA'S LEADING DISTRIBUTORS

In Canada: Irving Smith, Ltd., Montreal

*Reg. Trade Mark of DUPONT

The Custom Stripmaster is just one of a complete line of Ideal strippers including Thermo-Strip and high-speed electrically powered models for every insulation-removal need. WRITE FOR NEW WIRE STRIPPER BROCHURE.

IDEAL INDUSTRIES, Inc.
1420-L Park Ave., Sycamore, Ill.

Please send me a copy of your new WIRE STRIPPER BROCHURE

Name_____

Company_____

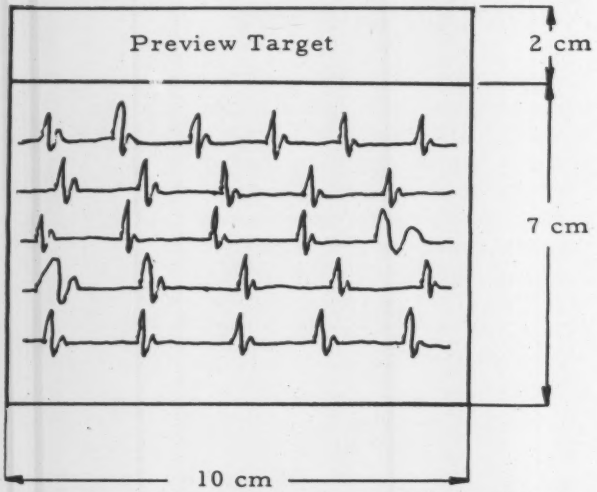
Address_____

City_____ Zone_____ State_____

CIRCLE 39 ON READER-SERVICE CARD

Storage Scope and X-Y Recorder

The Type 1220 is a specialized oscilloscope incorporating a newly developed Analab storage tube . . . which has both a preview target and a storage target. The preview target is used as an electronic "scratch pad" and



makes it possible to set up a display without cluttering the storage target area, prior to freezing the data. The preview target, consisting of P1 screen material, may also be used for conventional oscilloscope applications . . . The storage target area is coated with potassium chloride that is vaporized onto the target plate under specialized conditions to give it storage properties when bombarded by a high energy electron beam. Images of high contrast that are traced on the screen can remain stored for several months, even when the instrument's power is shut off. A stored image may be erased in 30 seconds . . . (*From new 4-page Spec Sheet, Analab Instrument Corp., 30 Canfield Rd., Cedar Grove, Essex Co., N. J.*)

FOR THIS LITERATURE CIRCLE 198 ON READER-SERVICE CARD

Proximity Control

The sensing element (probe) of the Trimount Proximity Control is installed in a position in the vessel or bin where a change in the proximity of the material will alter the capacity of the area surrounding the probe. This

change is amplified and used to operate the power relay. The probe is not affected by turbulence vibration or foaming as it has no moving parts . . . Failure of the instrument for any cause will stop the entire process. This means absolute safety control for your operation . . .

All models are supplied complete with interchangeable plug in unit; indicating meter; gasket sealed case with clear vision cover power indicating light; relay indicating lights; balance controls; operational test buttons; on-off switch; and fuse . . . (*From new 4-page Bulletin* 608482, *General Controls Co., Trimount Instrument Div.,* 8080 *McCormick Blvd., Skokie, Ill.*)

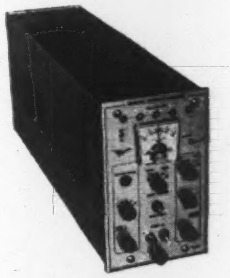
FOR THIS LITERATURE CIRCLE 199 ON READER-SERVICE CARD

IT'S NEW

from

ALINCO

MODEL SAM-1



SENSOR ANALOG MODULE

Just 4¼" wide and only 7" high yet contains a complete signal conditioning system including:

Amplifier
Automatic Calibrator
Transducer Power Supply
Bridge Balance Unit
Output Level Indicator

For the first time, component compatibility is no longer a serious problem for those designing signal conditioning systems. "SAM" now permits designers to specify system requirements rather than individual component specifications. Although the instruments comprising "SAM" are miniaturized and packaged into an extremely compact module, absolutely no sacrifice has been made in the performance specifications of individual components. In fact, the system specifications of "SAM" surpass the individual specifications of competitive instruments. This universal system features .02% over-all stability, low noise characteristics of less than 6 microvolts RMS over the full bandwidth of 40kc, and high output of up to 100 milliamps. Critical space and cabling problems are also alleviated since "SAM" requires just one-third the space and only one-half the cabling previously needed by other signal conditioning systems. Versatile "SAM" will accommodate ¼, ½, or full bridge transducers, strain gages, thermocouples, resistance thermometers, and potentiometer type transducers. Write today for full details.

ALLEGANY INSTRUMENT CO.
Div. Textron Electronics, Inc.
1091 Wills Mt. Cumberland, Maryland

CIRCLE 40 ON READER-SERVICE CARD

IT'S NEW

from

ALINCO

MODEL 151-C2

PRESSURE CELL

Combines high performance with exceptional overload capability.

Model 151-C2 is:

Bonded
Small
Rugged
Economical

The accuracy of this new pressure cell is the highest offered today, and is protected by the ability of the transducer to withstand extreme overloads of 500% with no change in performance. In addition, an exceptionally high margin of over 2,000% is provided for rupture pressures; thus offering a very high factor of safety when dangerous pressure media are involved. No gaskets, O-rings, or sealing compounds are used in the pressure head of the Model 151-C2. The metal-to-metal seal is unaffected by extreme temperatures and reactive pressure media. The design of the Model 151-C2 Pressure Cell permits the insertion of an auxilliary diaphragm, which completely seals off the primary diaphragm from the pressure media. This allows the auxilliary diaphragm material to be chosen for best possible resistance to unusually corrosive pressure media. Model 151-C2 is available in ranges from 25 PSI to 200 PSI. For lower ranges, request information on Model 151-C3; for higher ranges, request information on Model 151-C1.

ALLEGANY INSTRUMENT CO.
Div. Textron Electronics, Inc.
1091 Wills Mt. Cumberland, Maryland

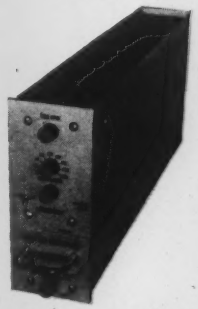
CIRCLE 41 ON READER-SERVICE CARD

IT'S NEW

from

ALINCO

MODEL 517



DC AMPLIFIER

A versatile differential wideband amplifier featuring:

Extremely Low Drift
10 v. DC Or Peak AC Output
Exceptionally Low Noise

The heart of the "SAM" system has been packaged separately and is now designated as the Model 517 Amplifier. While an integral part of "SAM," this completely transistorized amplifier achieved such high standards of performance in low-level amplification that Alinco decided it should be offered separately as a solution to many special amplification problems. In addition to the improvement of all important performance specifications—frequency response, output impedance, input impedance, drift, linearity, noise, and common mode rejection—this flexible design offers versatility and economy. Through the use of three different plug-in attenuators, the basic amplifier may be employed as either a differential or single-ended amplifier. These unique plug-in attenuators provide economical circuit modifications for specific applications which formerly required three special-purpose amplifiers. We will gladly answer your technical questions concerning the design and characteristics of Model 517. Write for full details today.

ALLEGANY INSTRUMENT CO.
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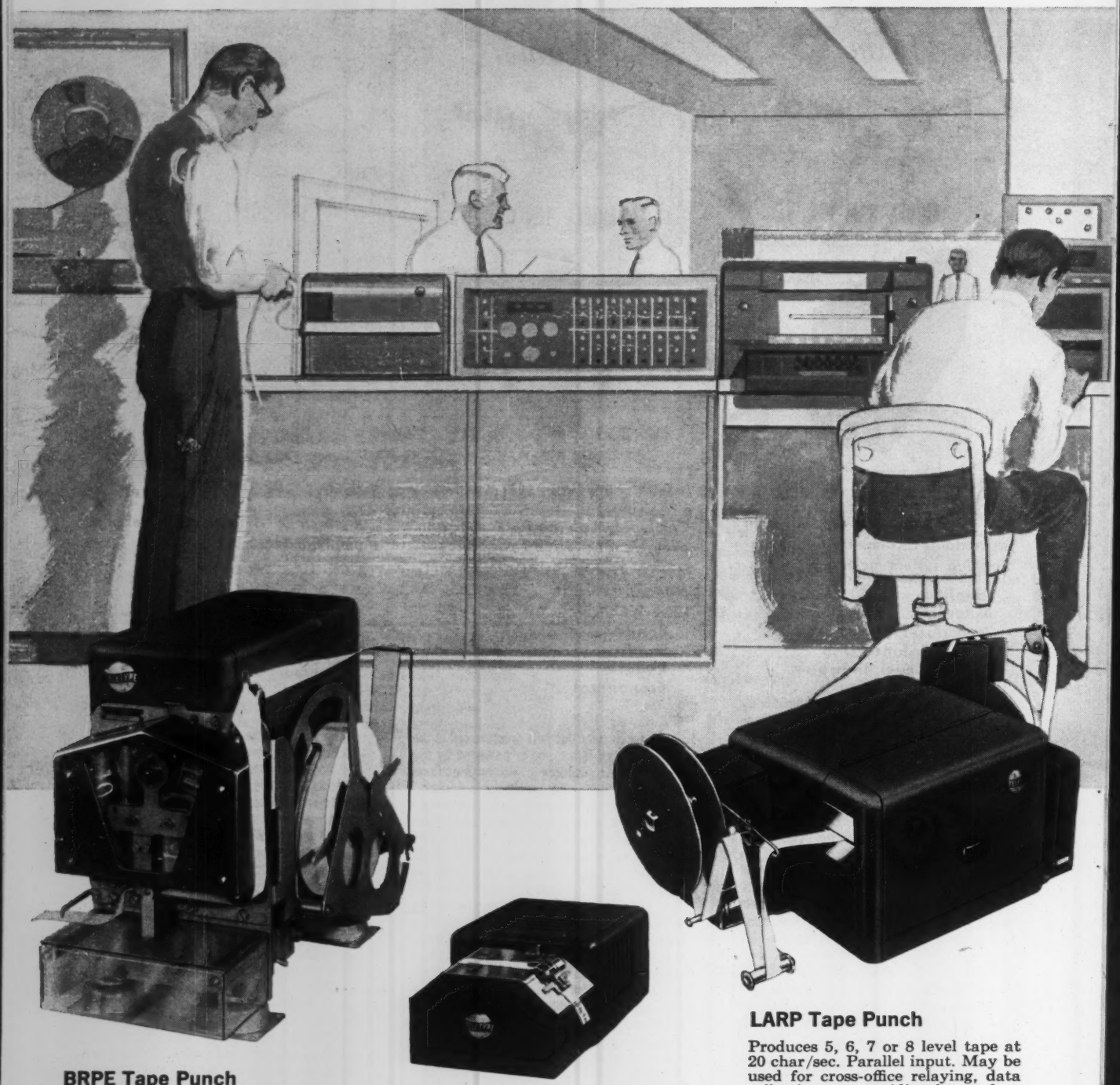
1091 Wills Mt. Cumberland, Maryland

CIRCLE 42 ON READER-SERVICE CARD

Looking for a solution to your



BRPE Tape Punch

Perforates 5, 6, 7 or 8 level tape at 100 char/sec. Synchronous unit, with parallel-wire input. For business machine readout, or, with deserializer, for data reception over DATA-PHONE or other high speed communication channels.

CIRCLE 425 ON READER-SERVICE CARD

CX Tape Reader

Reads fully perforated or chadless tape—5, 6, 7 or 8 level codes—at 100 char/sec. For use as computer input device, or, with serializer, for transmission over DATA-PHONE or other high speed communication channels.

CIRCLE 43 ON READER-SERVICE CARD

LARP Tape Punch

Produces 5, 6, 7 or 8 level tape at 20 char/sec. Parallel input. May be used for cross-office relaying, data collection, or providing by-product tapes from business machines. Companion input tape reader available (LX).

CIRCLE 426 ON READER-SERVICE CARD

data communication problems?

LBXD Tape Reader

Dual-purpose model: permits, (1) tape transmission on-line and/or to business machines, or (2) direct read-out (without tape) from business machines for on-line transmission. Speed, 10 char/sec; 5, 6, 7 or 8 level codes.

LPR Typing Tape Punch

Produces 5-level "common language tape," prints data right on tape for handling ease. Speed, 10 char/sec. Non-typing version of this unit also available (LRPE).

LXD Tape Reader

For on-line transmission of 5, 6, 7 or 8 level tape at 10 char/sec. Transmission may be pulsed.

Teletype Corporation offers an extensive line of paper tape punching and reading equipment, with capabilities for meeting a wide variety of needs. In addition to the individual units illustrated, numerous combination sets are available—such as gang-mounted punches and readers, punch-reader relay sets, high-low and low-high speed converters, and page-tape consoles.

Applications range from high or low speed on-line transmission to centralized data collection . . . data distribution . . . data input/output for business machines . . . by-product tapes . . . and many others.

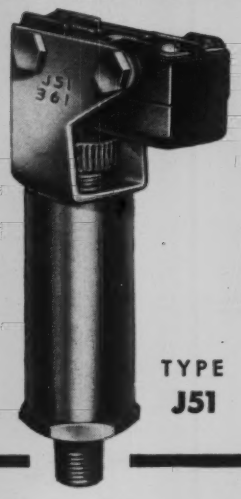
With Teletype-built tape units, you can solve your problems with precision-engineered equipment, backed by over fifty years of continuous design and manufacturing skill in the data communications field.

Teletype equipment is manufactured for the Bell System and others who require the utmost reliability and versatility from their data communications systems. For further information, write to Teletype Corporation, Dept. 22M, 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®

CORPORATION • SUBSIDIARY OF *Western Electric Company* INC.

Wide Range Space Saving **J51**



PRESSURE VACUUM CONTROL

TYPE **J51**

United Electric's Type J51 Pressure-Vacuum Control is a skeleton, precision-built unit that is used extensively in applications where space and weight are factors. It has an uncalibrated adjustment that may be provided with locking feature if desired. It is a rugged, wide range control suitable for a multitude of uses.

Adjustable Ranges . . .	Models available in ranges of 50, 75, and 250 psi between 0 and 350 psi limits.
Switch Differential . . .	Approximately 5 or 10 psi dependent on model.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. Also available are 20 amps. A.C., manual reset, D.C., and other switches.
Switch Types	Normally Open, Normally Closed, or Double Throw — no neutral position.
Maximum Pressure . . .	350 psi.
Electrical Connections . .	Lead wires attached to screw type terminals on switch.
Pressure Connection . .	Via a ⅜" male NPT connection.
Mounting	Via pressure connection.
Bellows Material	Either type 321 or 347 stainless steel.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. Standard units can be modified or custom-built units made to your specifications. Additional information on pressure and vacuum controls is available upon request.*

UNITED ELECTRIC

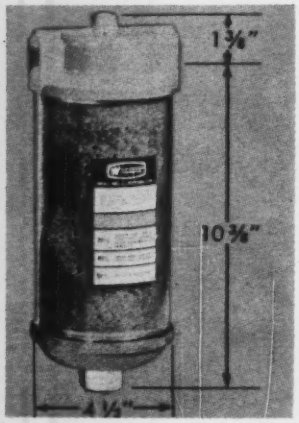
CONTROLS COMPANY

85 School St., Watertown, Mass.

CIRCLE 44 ON READER-SERVICE CARD

Gas Dryers

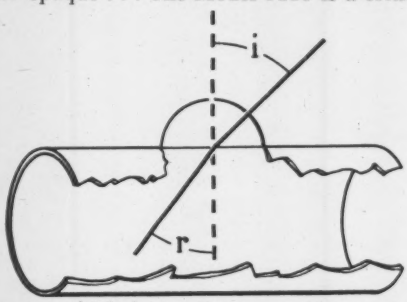
Model 4001-2, the basic unit of the Wilkerson line of dehydrators, lowers 4,200 cubic feet of air to —45°F when saturated entering air is 90°F or below, and pressure is not higher than 150 psi. This unit holds 2.5 lbs of Model 85-059 silica-gel, shipped in separate vacuum sealed cans (one can included with each unit). Most ideal for use on air flows of 10 SCFM or less. Color of desiccant changes from dark blue to pale pink as the moisture saturates it. To re-use 3 or 4 times, desiccant can be reactivated in a flat shallow pan and heated to 350°F until it turns dark blue again. Desiccant meets requirements of MIL-D-3716, and is grade 42 blue silica-gel. Nominal particle size is through 6 on 16 mesh. Unit will remove about .55 lbs of water, before it needs reactivation or replacement . . . (*From new spec sheet, Wilkerson Corp., Englewood, Colo.*)



FOR THIS LITERATURE CIRCLE 200 ON READER-SERVICE CARD

Refractometer for Fluid Process Streams

The Daystrom Indexometer is coupled directly into flow stream or bypass line, and provides a constant measurement of changes in the refractive index of binary mixtures —clear or opaque . . . The Model 5180 is a critical angle



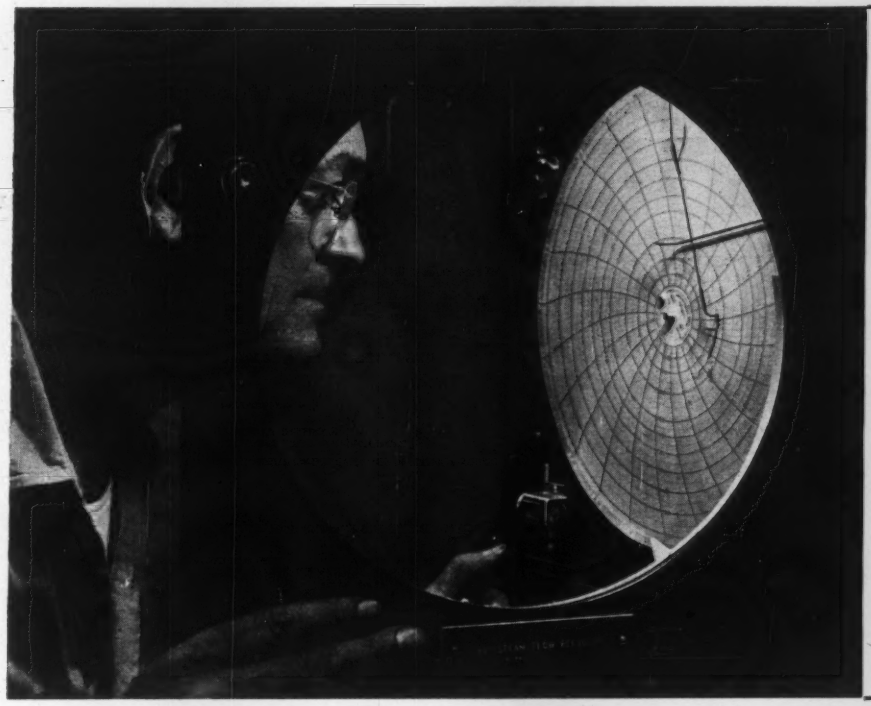
refractometer which has only one moving part—a Daystrom Light Chopper Prism. The instrument requires no standard samples, has no servo-repositioning movements, and eliminates the need for precise sample temperature and flow regulation. It is completely compensated against apparent refractive index changes due to temperature variations . . .

As applied to Indexometer operation, refractive index (RI) may be defined as the ratio of light velocity in a viewing prism (V_1) to the velocity of the same light in the fluid under investigation (V_2). This relationship is expressed by Snell's Law as: $RI = V_1/V_2 = \sin i/\sin r$, where i is the angle of incidence and r is the angle of refraction . . . (*From new 4-page Bulletin 16-001, Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N. J.*)

FOR THIS LITERATURE CIRCLE 201 ON READER-SERVICE CARD

Continued on page 2212

Which of these round chart recorder inking problems do you now have?



- ☐ **Clogged pens because of open-bucket systems**
- ☐ **Frequent refilling . . . resulting in excessive maintenance**
- ☐ **The mess of syringes and droppers**
- ☐ **Breakage of plastic bags and glass ink containers**
- ☐ **Flooding or starving at pen tip**

New Esterbrook Mark-Trol solves them all, and completely pays for itself in days

Mark-Trol is a universal marking system . . . completely sealed . . . replaceable ink cartridge

Mark-Trol is a convenient conversion kit, enabling you to change over virtually any round chart recorder marking device in use today—in 10 minutes or less. Then your inking problems are over and done with.

Esterbrook knows that recorders don't operate in a vacuum, so they designed a marking device that does. From stylus tip to disposable ink cartridge, Mark-Trol is a completely sealed capillary system. You get a perfect chart record every time under any service condition, inside or out . . . humidity, precipitation, chemical fumes, dust, and in temperatures of from 0°F to 145°F. Contaminants are kept out, mess and mishaps are designed out. No clogging, flooding or starving. This faultless performance plus a generous ink supply in the cartridge mean that Mark-Trol operates up to 9 months without maintenance. And then the only servicing ever required is an occasional look through the window and replacement of the ink cartridge—and you do that in seconds.

Esterbrook has established a wholly new standard of reliability with Mark-Trol, and proved it in 2½ years of field tests in the power and processing fields.

ORDER ONE FOR TRIAL—We welcome your trying a make-sure installation with an order for a Mark-Trol kit.

Esterbrook®
MARK-TROL*
THE ESTERBROOK PEN COMPANY
TECHNICAL PRODUCTS AND INSTRUMENTS DIVISION
*Trademark

Authorized Distributor:
Technical Recording Chart Division
Graphic Controls Corporation
189 Van Rensselaer St., Buffalo 10, New York

Please send us.....Mark-Trol Conversion Kits at $12.00 each.

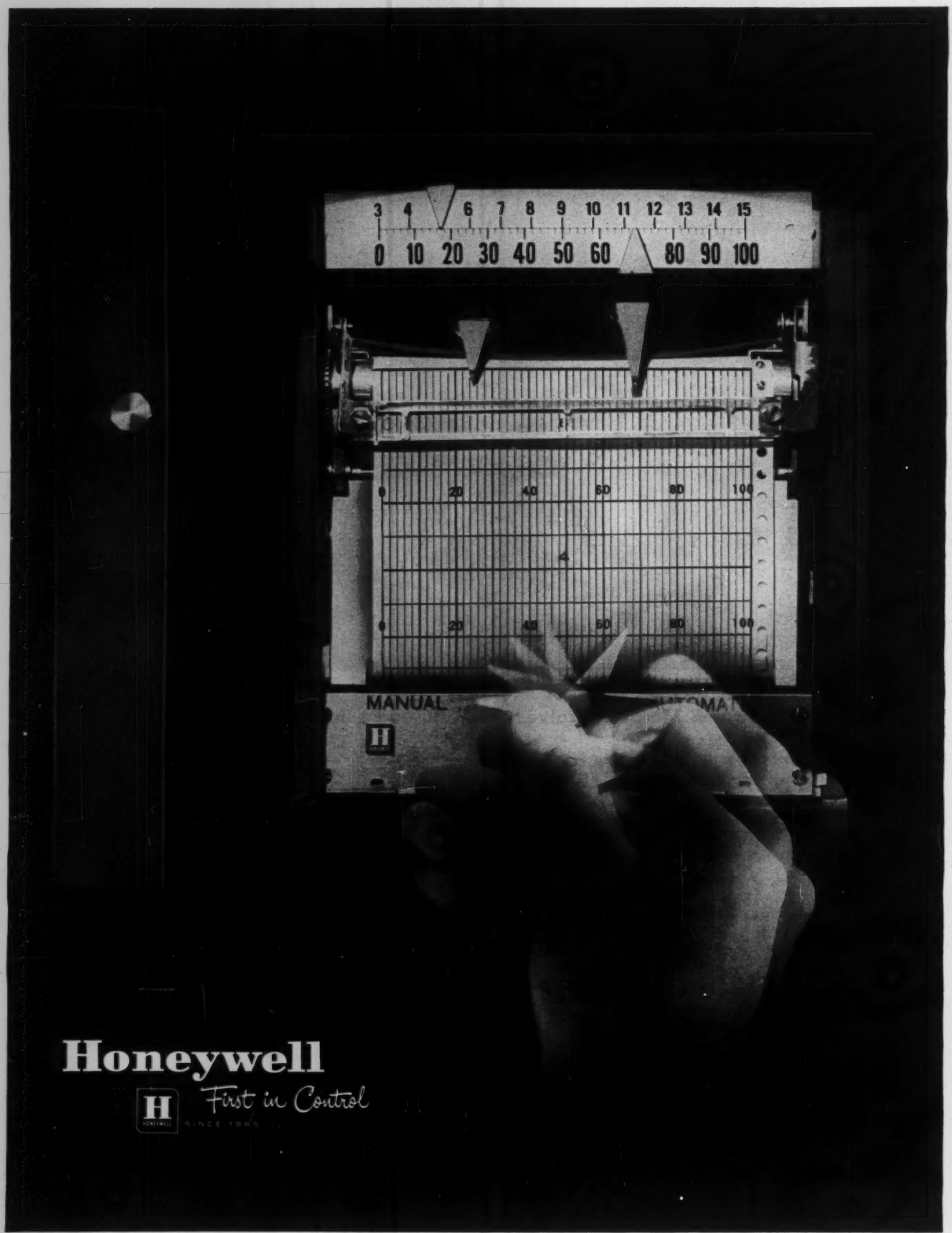
Name.....Title.....

Company.....

Address.....

Please also send literature completely describing Mark-Trol. ☐

CIRCLE 45 ON READER-SERVICE CARD


3 4 6 7 8 9 10 11 12 13 14 15
0 10 20 30 40 50 60 80 90 100
MANUAL
Honeywell
First in Control

Automatic Switching Eliminates Matching of Pressures *with*

New Honeywell PneumatiK Tel-O-Set Instrumentation

Honeywell brings new features, new performance to small case instruments with the introduction of *PneumatiK Tel-O-Set Instrumentation.* Here are just a few of the many new features:

Automatic Switching Just a flip of the control lever switches the instrument from automatic to manual or vice versa. There are no bumps, no delays, no matching of pressures required. This simplified switching makes cascade control systems practical for the operator.

Easily accessible adjustments Zero and damping adjustments to pen can be made while the pen is recording. Effects of adjustments can be seen *while* they are being made. Since it is not necessary to withdraw the recording chassis to make adjustments, there is no possibility of causing a pen zero shift.

Interchangeable chassis and controllers Recording and indicating chassis are interchangeable. Just pull out one chassis and plug in the other. Quick-connect air terminals eliminate the need for tubing connections. Two- and three-mode controllers with backset adjustments are also completely interchangeable.

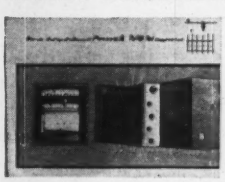
Easy-to-read, easy-to-change 4-inch charts Pen position on the 4-inch chart permits instantaneous reading of variables at all times. Pen arm design also permits rectilinear recording. Front-loading, tilt-out chart drive makes it easy to change chart rolls in a matter of minutes.

All cases fit 6 x 6 cutouts All models fit standard panel cutout of 6″ x 6″. Overall dimensions: 6¾″ wide; 7½″ high; 15¼″ deep.

Calibrated control adjustment Adjustments to controller can be easily made from back of the panel by removing controller cover. Calibrated dials for each adjustment ensure precise setting of proportional band, reset and rate values. Optional front-set control adjustments make it easy to set control from front of panel.

Easy to remove components To remove any particular component from the case, it is only necessary to loosen a screw or lift a latch.

HANDY DEMONSTRATOR-IN-PRINT Get the full story on new Honeywell *PneumatiK Tel-O-Set* Instrumentation by writing for this handy demonstration-in-print. This booklet covers in words and pictures all the important installation, operation and maintenance features of the new line. It will help you evaluate the many advantages *PneumatiK Tel-O-Set* holds for your process. Send for it today. MINNEAPOLIS-HONEYWELL, 4402 Wayne Avenue, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.



HONEYWELL INTERNATIONAL Sales and Service offices in principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

CIRCLE 46 ON READER-SERVICE CARD

FREE SOLENOID VALVE DATA!...from VALCOR

"HOW TO SPECIFY SOLENOID VALVES", an 8-page brochure complete with drawings, diagrams, charts and curves.

"SOLENOID VALVE SELECTIONS FOR CORROSIVE APPLICATIONS", a 16-page manual listing over 500 corrosive media.

Both are free. Both should be at your fingertips.

Write today for your copies!

VALCOR SOLENOID VALVES

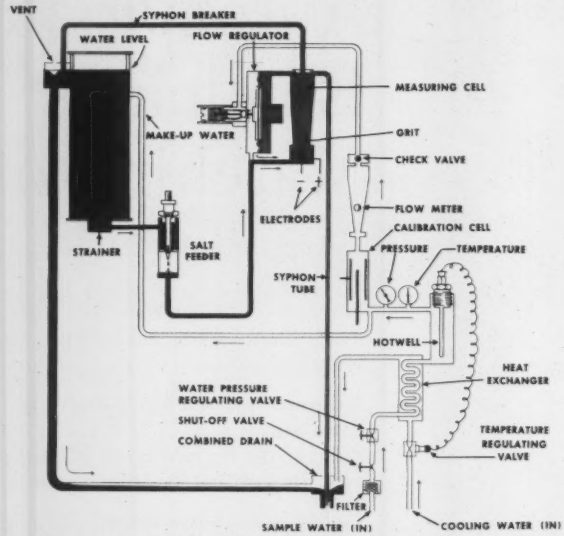
VALCOR ENGINEERING CORP.

5366 Carnegie Avenue, Kenilworth, N. J. • CH 5-1665

CIRCLE 47 ON READER-SERVICE CARD

Dissolved-Oxygen Analyzer

The D-O Analyzer is a basically electro-chemical, direct-acting instrument. Dissolved oxygen reacts with a pair of electrodes in a sampling cell. An electric current proportional to the amount of oxygen in a continuous



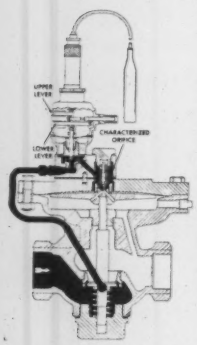
sample is generated. This current operates an indicator (calibrated in parts per billion of dissolved oxygen) from which a signal may be transmitted to any standard millivolt recorder. Precise control of the instrument's hydraulic variables assures accurate measurement . . .

Conductivity of the sample water is kept constant by a precisely controlled feed system which adds sodium chloride solution. This solution is produced continuously and automatically using water from the sample to avoid introducing oxygen from some other source . . . For calibration purposes, an electrolytic cell adds precisely controlled amounts of oxygen to the sample water . . . (*From new 5-page bulletin, Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.*)

CIRCLE 202 ON READER-SERVICE CARD

Temperature Regulator

Leslie-Propo-Matic is a new, patented self-contained regulator design. Just a twist to tune and the unique adjustable proportional band matches regulator response to your heating requirements for optimum stability.



Temperature variations at the bulb are translated into corresponding changes in the steam pressure delivered by the regulator. Here's the chain of action: as increases or decreases in temperature occur at the bulb, the liquid fill in the thermal system expands and contracts proportionately to create positive stem positioning. This motion is transmitted to the pilot valve. The pilot valve admits stream to the top side of the Spiroflex® diaphragm. . . . (*From 4-page Bulletin 612A, Leslie Co., Lyndhurst, N. J.*)

Continued on page 2220

CIRCLE 203 ON READER-SERVICE CARD

FOR MORE PRODUCT DATA

CIRCLE THE NUMBER that corresponds to the number appearing with the product reported or advertised in this issue.

PRINT YOUR NAME, title, company, address, etc., clearly, detach and mail. No postage needed.

Coming—

During 1962 I&CS' editors will spotlight different aspects of instrumentation and control each month . . .

- **January—Electrical Measurements,** and review of Magnetic Drum and Disc Storage Devices
- **February—Pressure Instrumentation,** and review of Telemetry
- **March—Programming and Timing**

Every other issue will also emphasize a particular control topic.

Non-subscriber readers—not to miss a particularly useful issue—can use the card opposite page 2213, this issue, to subscribe.

Advertisers can reserve space in any or all of 1962 "special" issues, by contacting our nearest rep—per list on page 2166.

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12/61

PRODUCT INDEX

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This index is published as a service. Every care is taken to make it accurate, but I&CS assumes no responsibility for errors or omissions.

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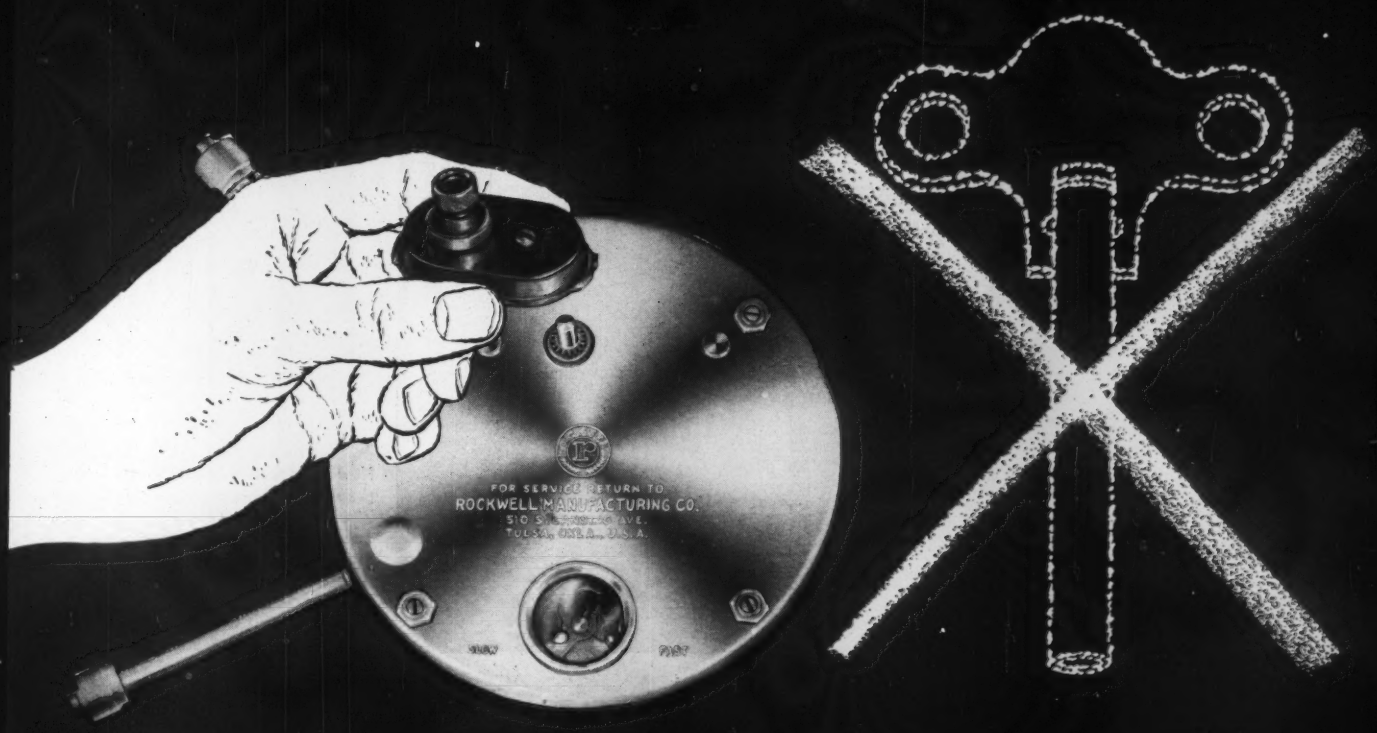


Illustrating how speed changing turrets are applied to the chart arbor

You never need to wind the Rockwell Gas Drive

GAS (OR AIR) POWERS THIS NEW CHART TIMING DRIVE. With it you can forget the costly chore of periodic winding. It's completely self-starting, self-contained. You can use the Rockwell Gas Drive with profit and gain accurate, automatic operation of recording charts on practically any make orifice meter, gas lift intermitter, pressure recorder or temperature gauge. It is particularly applicable for remotely located instruments.

Since the Rockwell Gas Drive consumes only 6 cubic feet of gas in 24 hours it is economical to use—safe, too, for there is no exhaust problem.

The Gas Drive operates on a pressure range of 15-25 psi and delivers 15 in. lbs. of torque to the main arbor which rotates once every 24 hours. Geared turrets which snap onto this arbor provide optional speeds of 2, 3, 4, 6, 12, 48 or 72 hour, 7 or 8 day rotation. So with a stock of Rockwell Gas Drives, plus a selection of economical turrets, you can serve all your instrument needs. Get facts now. Write Rockwell Manufacturing Company, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Guelph, Ontario.

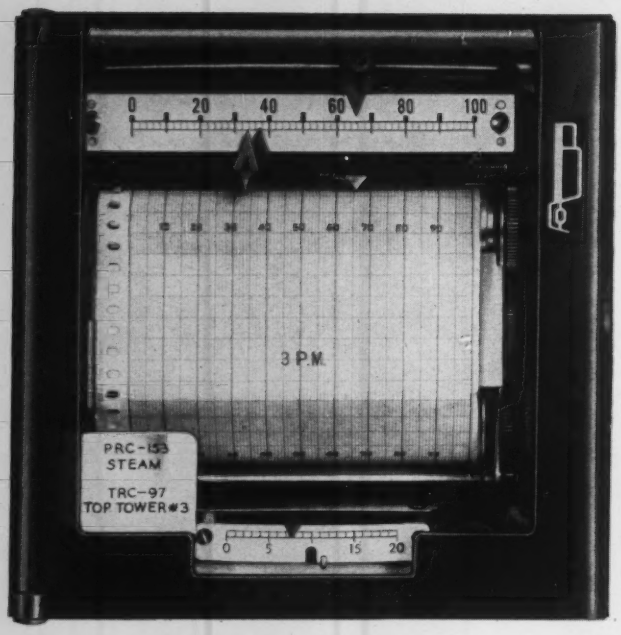
◀ Rockwell Gas Drive powers this typical intermitter

GAS DRIVES, CHART DRIVES

another fine product by

ROCKWELL

CIRCLE 48 ON READER-SERVICE CARD



New Bristol Series 670 Metagraphic receivers measure only 7" wide by 7⅛" high on panel, come in a wide selection of models, including 1-, 2-, and 3-pen models and models with manual-automatic, manual-cascade, and manual-automatic-cascade control stations.

Now: the USER-PLANNED Receiver *New Bristol Metagraphic*

offers you more features for easy installation, flawless operation, and fast, no-down-time servicing than any other 4-inch-chart pneumatic receiver.

At last, here's the ideal pneumatic receiver for graphic panel applications.

It's Bristol's new Series 670 Metagraphic, the receiver with complete plug-in versatility and convenience, plus these new user-designed features:

Simplified control switching between functions—Allows the easiest start-up procedures for automatic or cascade operation. Just adjust process to line up color-coded indicators and switch to automatic or cascade operation as desired.

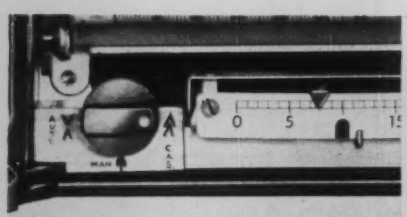
Uniform control switching—All receiver models have the same convenient, easy-to-remember switch positions for the various types of control: cascade position; 3 o'clock; manual position, 6 o'clock; and automatic position, 9 o'clock.

Simplified chart change and inking—Chart changing is a one-hand operation. A new chart can be slipped into place in an instant. The capillary inking system can be filled from the front of the receiver.

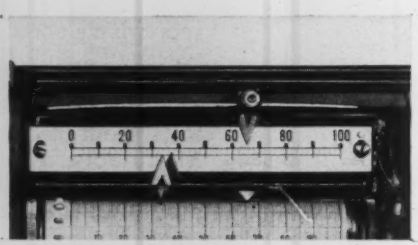
And that's not all: Series 670 gives you such outstanding features as rectilinear chart coordinates for easiest reading, easy connections for any type of control, and sparkless mercury-switch disconnect of electrical circuit when plug-in chassis is withdrawn.

Write for complete data on the new Series 670 today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn., a Subsidiary of American Chain & Cable Company, Inc. 0.43

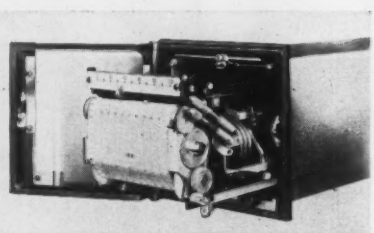
ACCO



Simplified, uniformly-planned control switching facilitates process start-up and operator training.



Brightly-colored distinctively-shaped pointers signal process deviation from set-point, even at a distance.



Complete plug-in versatility—long a Metagraphic feature—insures continuity of service.

BRISTOL...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

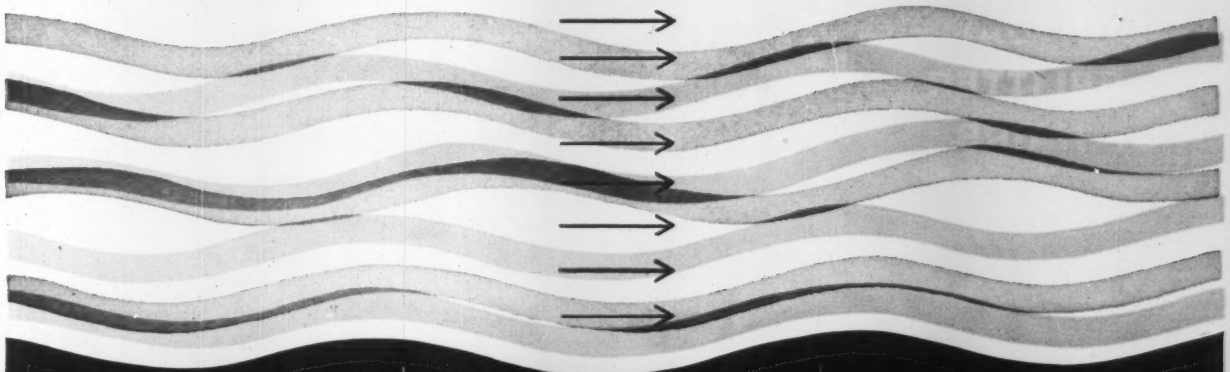
CIRCLE 49 ON READER-SERVICE CARD

Honeywell announces the NEW series 1400 low flow control valve

The addition of the new Series 1400 valve body to the Honeywell line of control valves now gives you a choice of actuator-body combinations to match your applications. Now you can choose the exact type and degree of control you need, without pushing a valve beyond its design limits . . . or without paying for more performance than you need.

The compact Series 1400 valve body is available in a full range of materials, ratings and sizes, with screwed or flanged ends. It can be used to regulate small flows in process, pilot plant, research and commercial control systems. Each body size (½", ¾" and 1") has a wide range of reduced ports with Cv's from .025 to 11.0. Two bonnet constructions facilitate mounting of five types of actuators —three pneumatic and two electric.

Each actuator-body combination fits a different range of operating conditions and performance characteristics, but with sufficient overlapping of these ranges to give you a wider selection on the basis of cost. For complete details, write for Bulletin B803-1. MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.



Model 1401 Low Flow Valve with heavy-duty pneumatic actuator for systems requiring high shut-off ratings and accurate valve positioning.

Model 1403 Low Flow Valve with compact, light weight pneumatic actuator for average industrial and commercial control systems.

Model 1404 Low Flow Valve with reduced port Cv's to .025 and top-mounted positioner integral with pneumatic actuator.

Model 1406 Low Flow Valve with *Modutrol* capacitor-type electric motor actuator for two-position, floating or proportional control.

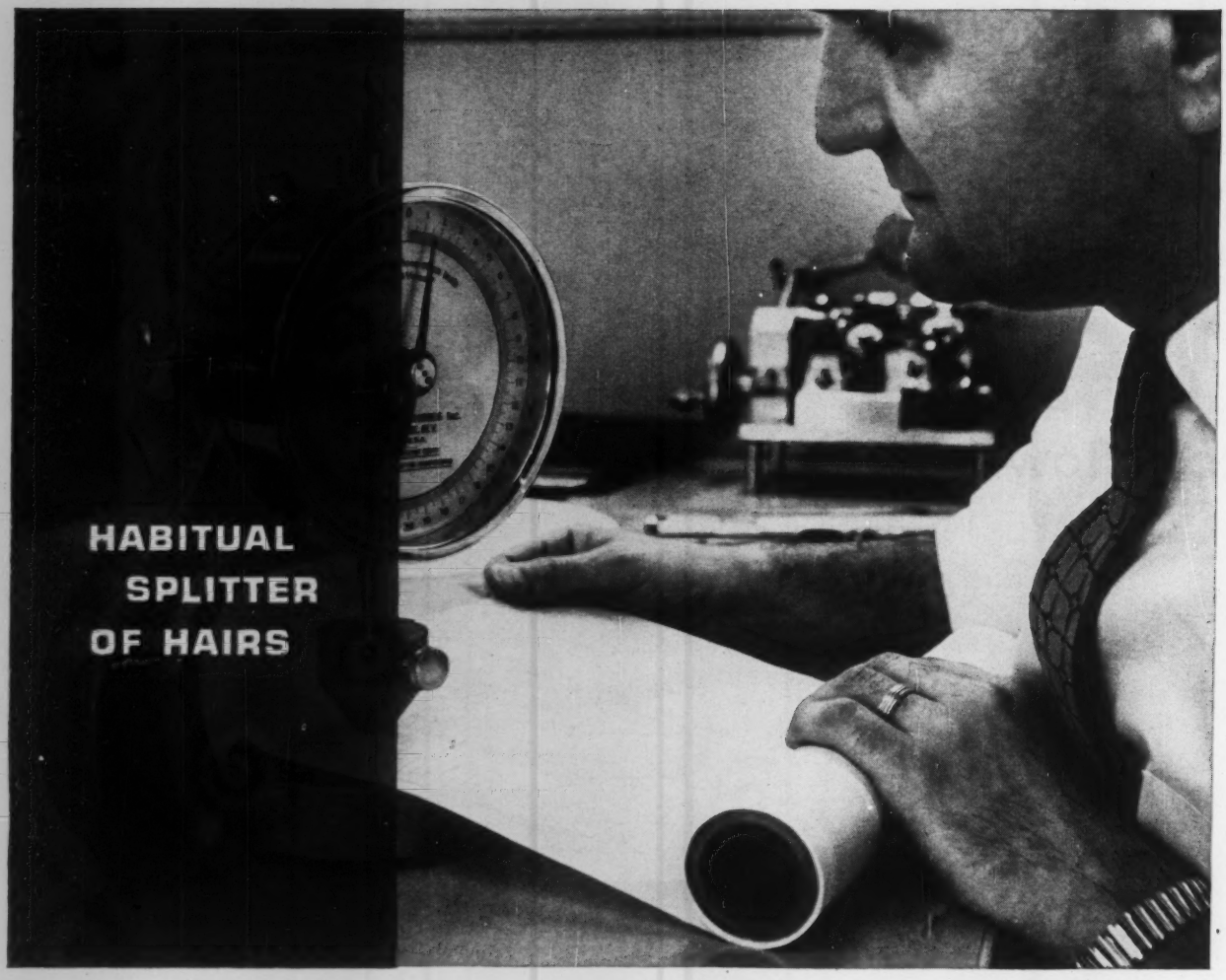
Model 1407 Low Flow Valve with heavy-duty *Actionator* electric motor actuator provides more power for higher valve shutoff ratings.

Honeywell

H First in Control

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

CIRCLE 50 ON READER-SERVICE CARD



. . . because a mil can matter greatly in

RECORDING CHART PERFORMANCE

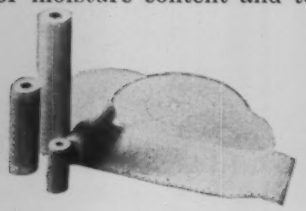
Even a fraction of a mil can bulk large in the thickness of a recording chart. That's why John Mazurowski and his thickness micrometer are so important to chart users.

A process change in an eastern oil refinery, for example, called for a longer strip chart in a temperature recorder — but the diameter of the roll could be no bigger than before. GC engineers solved this problem by working with our paper mills to reduce chart paper thickness from 0.00275" to 0.0019" while preserving strength and flexibility.

To make sure our charts meet the requirements of your instruments, GC engineers test paper stock for moisture content and tear-strength, too. This rigid inspection of paper that is produced exactly to GC specifications is a major reason why GC Recording Charts consistently fulfill their promise of accurate performance.

Other reasons for GC quality include our special formula printing inks, our exclusive innovations in plate-making and printing, and the scrupulous humidity control maintained throughout our manufacturing and storage areas.

GC Recording Charts have become standard equipment in more than 5,000 plants today. We stock more than 15,000 different charts — and will design and produce accurate special-purpose charts. Send for our new sample brochure.



RECORDING CHARTS

CIRCLE 51 ON READER-SERVICE CARD

I&CS 1962 Buyers' Guide Errata

All recipients of the Guide are urged to note the following changes and to correct their copies of the 1962 edition (received as Part 2 of October 1961 INSTRUMENTS & CONTROL SYSTEMS).

In the Directory Section:

Address for Pyro-Electric, Inc., is incorrect. It should read: Pyro-Electric, Inc., Muskin Rd., P. O. Box 65, Walkerton, Ind. Telephone 586-3144

Telephone number for Rex Rheostat Co. was incorrect. The correct address and telephone number: Rex Rheostat Co., 149 Babylon Tpke., Roosevelt, L. I., N. Y. FR 9-1030

This listing should be added: Comcor, Inc., 5310 E. Pacific Place, Denver 22, Colo. SK 6-3608;

and Comcor, Inc. should be listed in the Catalog Sections as follows:

Catalog 1, under:

COMPUTERS, Process Control

CONTROL SYSTEMS, General-Purpose, Electrical or Electronic

SERVOMECHANISMS, Digital, including Digital Positioners

Catalog 2, under:

COMPUTERS, Analog, Electronic

COMPUTING SERVICES, Analog

FUNCTION GENERATORS

Catalog 3, under:

AMPLIFIERS, Audio Frequency, Chopper, Saturable Reactors; Miscellaneous, including Geophysical, Nucleonic, Strain-gage Oscillograph, etc., Servo, Wideband

POTENTIOMETERS, Self-balancing, Automatic Control, Indicating and/or Recording

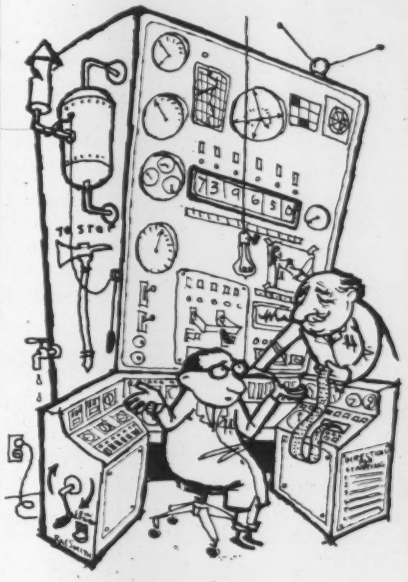
Catalog 5, under:

FIRE CONTROL INSTRUMENTS & SYSTEMS SIMULATORS, FLIGHT including Flight Tables

I&CS PANHANDLE PETE

The cartoon below was printed in our October issue without punch line—and books were offered for the best punch line suggested by our readers. To date more than 240 captions have been suggested—with more coming in every day. Here are some winners; more will be printed next month—and next month—and next month. (At last we know who our "average reader" is—a comedian.)

Panhandle Pete



"Maybe 1 and 1 is 10"
Chester Osterman, Leeds & Northrup, Phila.

"Maybe 2 and 2 is 3.999999"
Richard Morley, North American Aviation, Columbus, Ohio
George Gastler, Marshall Space Flight Center, Huntsville, Ala.

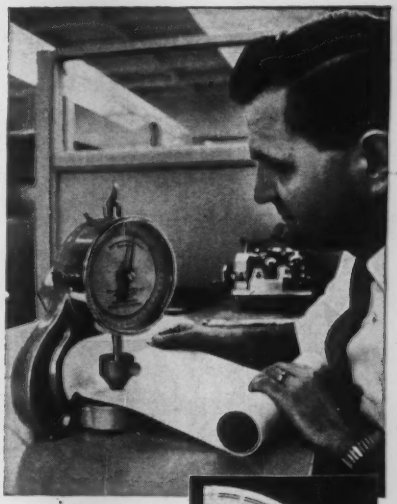
"It knows you bought it—and it still says you are overpaid"
George E. Werne, Memphis, Tenn.

"247,635,739,650 somethings"
John Belanich, Port Washington, N. Y.

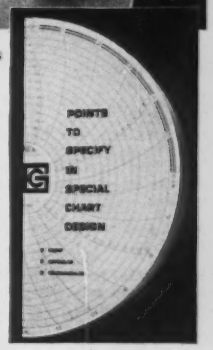
"It keeps asking who wants to know?"
Anonymous, Los Angeles, Calif.

"Sorry, we don't keep records of the questions"
Delmar Martin, Standard Electric Time Co., Springfield, Mass.
James McGough, Detroit, Mich.
Robert Nagel, Skokie, Ill.

"It says 'Snuggle Up'"
Miss Jean Paton, Hillsboro, N. M.



GC Recording Charts are accurate



New booklet helps solve SPECIAL CHART problems

If you have a unique recording or control problem which a stock chart won't fit, GC's experience will work for you.

This free booklet, "Points to Specify in Special Chart Design," offers many useful tips to consider before specifying or designing a special chart. It suggests possible types of paper, sizing of punched holes, ink colors, overprinting, grid line widths, etc.

GC service—and this booklet—can eliminate false starts and wasted time. Let us serve you. Just send this coupon.

GC RECORDING CHARTS

Use This Coupon

TECHNICAL RECORDING CHART DIVISION
GRAPHIC CONTROLS CORP.
189 Van Rensselaer St., Dept. IC
Buffalo 10, New York

Please send me your new folder "Points to Specify in Special Chart Design." No charge or obligation, of course.

Name_____
Firm_____
Address_____
City_____ State_____

CIRCLE 52 ON READER-SERVICE CARD

NEW NEW NEW NEW NEW NEW NEW NEW NEW

when it

MELTS

you know the *temperature!*

NEW *Markal*

THERMOMELT

TEMPERATURE INDICATORS

With Handy Adjustable Holder

The easy modern way to determine exact working temperatures!

Just mark or stroke the surface with THERMOMELT . . . when it reaches the desired temperature, the mark liquefies. There's no guesswork, no wasted time or material . . . THERMOMELT is the quick, precise way to determine heating temperatures. Accurate to within ±1%.

A Stik For Every Temperature from 113° F. to 2000° F.

ALSO AVAILABLE IN LIQUIDS AND PELLETS for inaccessible or hard-to-measure applications. Wide range of temperatures.

SEND TODAY for free THERMOMELT literature and pellet sample (indicate temperature desired).

Made by the Manufacturers of Markal Paintstik Markers and Protective Coatings.

MARKAL CO. 3080 West Carroll Avenue • Chicago 12, Illinois

CIRCLE 53 ON READER-SERVICE CARD

WIDE BAND FLUTTER METER

Specifically designed for laboratory work, the FL-4C a precision instrument, measures extremely small amounts of flutter with components up to 5,000 cps. Used in instrumentation, telemetering, data reduction, and television recording systems.

SPECIFICATIONS:

- Carrier frequency: 14.5 kc, ±0.012%.
- Indicators: ±2% drift and rms flutter meters.
- Range: 0.2, 0.6, 2.0 rms full scale.
- Flutter filters: 0.5 to 30 cps, 30 to 300 cps, 300 to 500 cps.
- Bandwidth: dc to 5,000 cps within 6 db.

For Additional Information write or phone

VARO Inc

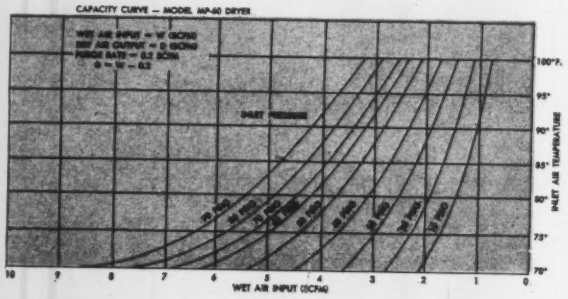
MICROELECTRONICS DIVISION

402 East Gutierrez, Santa Barbara, Calif. Phone WOodland 6-3116

CIRCLE 54 ON READER-SERVICE CARD

Desiccant Dryer

The MP-60 . . . delivers dry air with a dewpoint 100°F below ambient temperature, or better . . . operates with inlet air at any pressure from 10 psig to 90 psig . . . is delivered ready-to-operate with both chambers charged with



activated alumina desiccant (1.2 lb per chamber) . . .

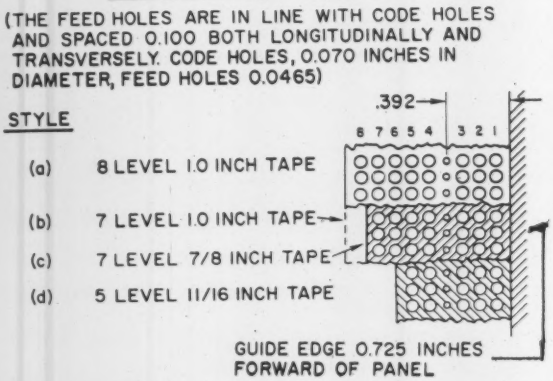
Moisture is removed from inlet air as it passes up thru a chamber of activated alumina desiccant. At the end of a two hour drying cycle, an automatic timer switches valve positions and diverts the moist inlet air stream to the second chamber for drying.

While one chamber is drying air, desiccant in the other chamber is being reactivated by heat from a built-in heater and a small flow of dry air for purging . . . (*From new flyer, Trinity Equipment Corp., Cortland, N. Y.*)

FOR THIS LITERATURE CIRCLE 204 ON READER-SERVICE CARD

Super-Speed Tape Perforator

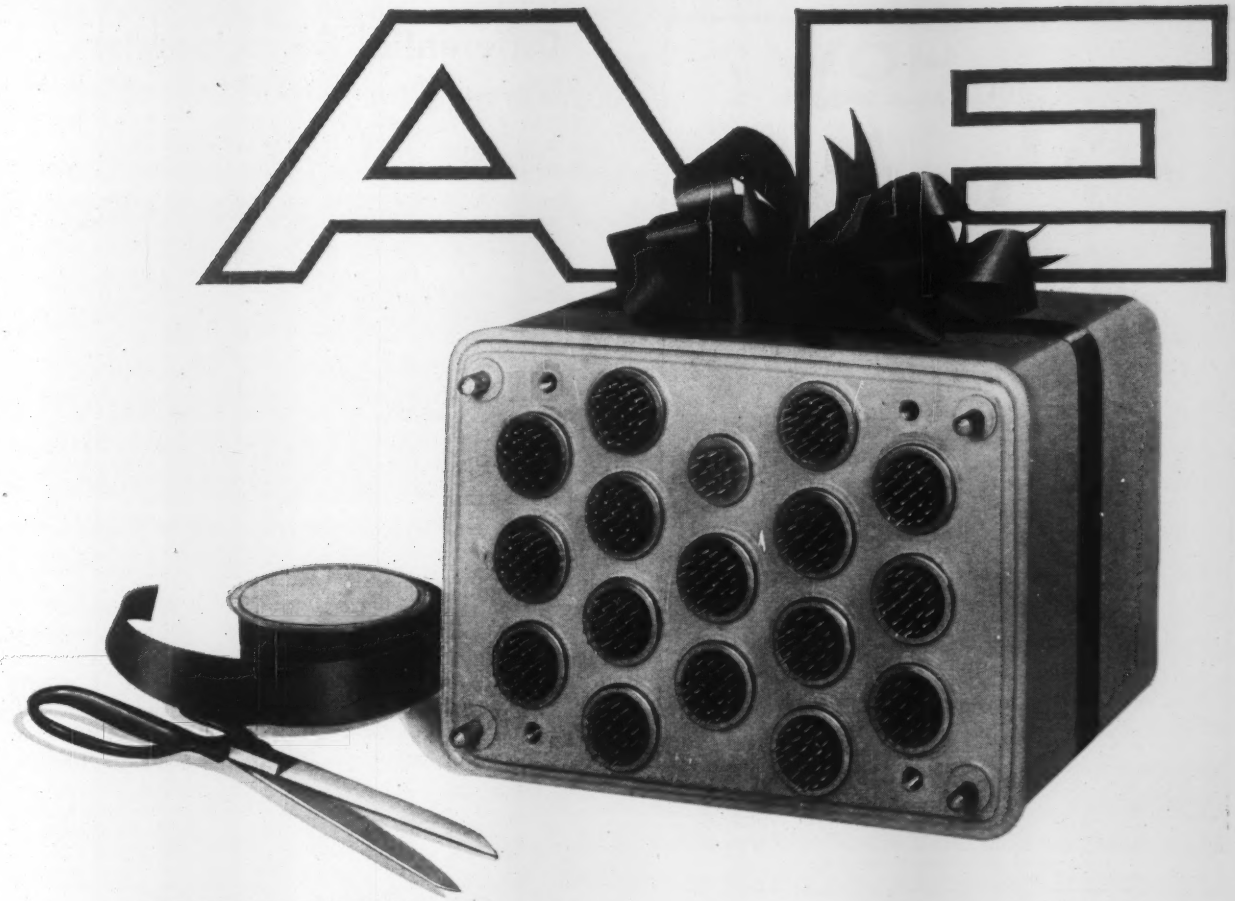
Model GP-2 Super-Speed Tape Perforator is a mechanism capable of recording digital data in standard perforated tape at extreme speeds. Hole patterns, or data codes are recorded at the rule of 300 per second, 3000


STANDARD HOLE PATTERNS
(THE FEED HOLES ARE IN LINE WITH CODE HOLES AND SPACED 0.100 BOTH LONGITUDINALLY AND TRANSVERSELY. CODE HOLES, 0.070 INCHES IN DIAMETER, FEED HOLES 0.0465)
STYLE
.392
8 7 6 5 4 3 2 1
(a) 8 LEVEL 1.0 INCH TAPE
(b) 7 LEVEL 1.0 INCH TAPE
(c) 7 LEVEL 7/8 INCH TAPE
(d) 5 LEVEL 11/16 INCH TAPE
GUIDE EDGE 0.725 INCHES FORWARD OF PANEL

words per minute. The punch can be accurately controlled to create nearly 10 million precisely located holes per hour . . .

At 300 codes per second, the complete recording operation must be performed in but 3⅓ milliseconds . . . Through appropriate over-voltaging, it is possible to reduce the electrical rise from 2.0 milliseconds to about 0.2 milliseconds. Drive of transistor coils from a 20 or 50 volt supply through an appropriate series resistor is recommended . . . (*From new 20-page booklet, Soroban Engineering, Inc., Box 1717, Melbourne, Fla.*)

FOR THIS LITERATURE CIRCLE 205 ON READER-SERVICE CARD



TO THE ENGINEER

who likes his switching gift-wrapped

If you want your control functions prewired, hermetically sealed in a neat package, tested out, and as ready as instant coffee, you're listening to the right people.

Because AE has a gift for wrapping up relays and stepping switches in tidy control packages of your design—or ours, if you prefer.

For instance, the control package illustrated houses an AE Type 45 Rotary Stepping Switch wired to multiple-pin headers for direct plug-in (and we supply the properly oriented socket mounting plate). This particular job has 462 connections, and could just as readily be equipped with MS connectors for insertion in matching cable plugs.

The point is, we've been wiring telephone switchboards and automatic control devices for years, and have the technique down pat. So pat that it would probably cost you less to let *us* do the job.

Besides, AE engineers are past masters at designing complex switching circuits. You can leave it to them, if you wish, to dope out the least expensive way of accomplishing the most sophisticated switching.

How about letting us in on *your* control problem? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Catalog 4083: "Hermetically Sealed Relays and Switches."

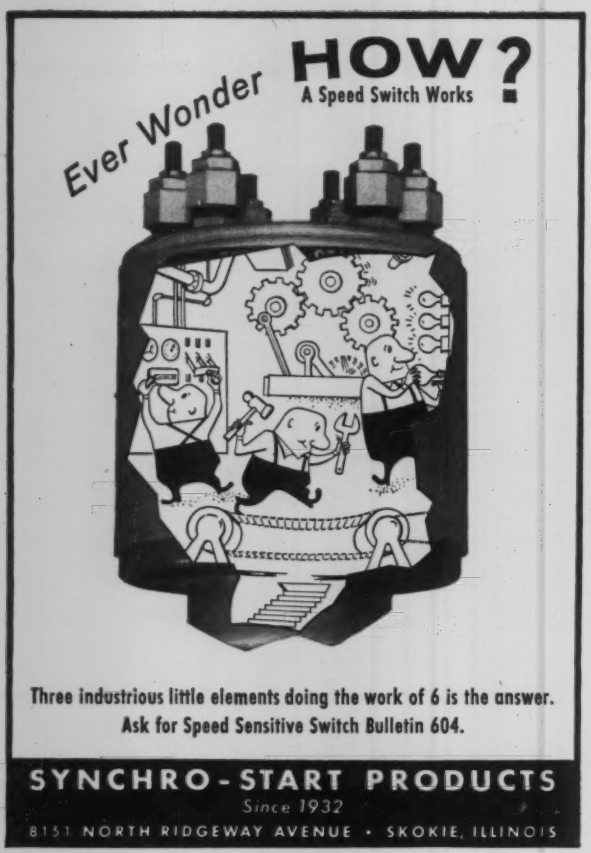
AE CAN DO

AUTOMATIC ELECTRIC GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

CIRCLE 55 ON READER-SERVICE CARD



Three industrious little elements doing the work of 6 is the answer.
Ask for Speed Sensitive Switch Bulletin 604.

SYNCHRO-START PRODUCTS
Since 1932
8151 NORTH RIDGEWAY AVENUE • SKOKIE, ILLINOIS

CIRCLE 56 ON READER-SERVICE CARD

OPTICS

A. D. JONES OPTICAL WORKS
2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368—3369

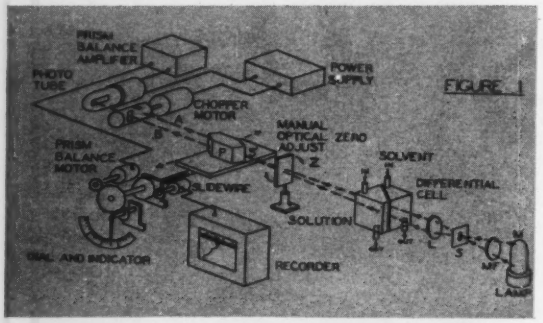
People usually associate Optics with glass only. The following materials, successfully processed here by sawing, grinding and polishing or drilling are of value to designers, engineers and manufacturers. Most materials are supplied by our customers for their orders.

ALUMINA
ALUMINUM
ARSENIC TRISULPHIDE
BARIUM TITANATE
BRASS
CALCIUM TUNGSTATE
CARBORUNDUM
CERAMIC
COBALT FERRITE
COPPER
CORNING 707
CORNING 7052
FERRITE
FERROX
FLUORIDE, CALCIUM
FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNESIUM STANIDE
NICKEL OXIDE
NIOBIUM
PLATINUM
POTASSIUM BROMIDE
PYREX
QUARTZ, CRYSTAL
QUARTZ, FUSED
SAPPHIRE
SILICON
SODIUM CHLORIDE
STEEL
STRONTIUM TITANATE
TEFLON
TITANIUM DIOXIDE
VYCOR
VANADIUM
X-RAY LEAD GLASS

CIRCLE 57 ON READER-SERVICE CARD

Differential Refractometers

The refractive index of a transparent material may be loosely defined as the light bending power of the material as compared with air. This light bending power is expressed precisely by Snell's Law of Refraction. Since



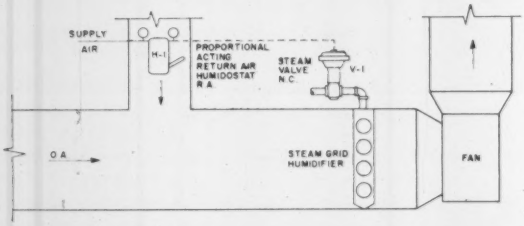
refractive index is a physical constant of a material and varies with chemical composition, refractive index measurements provide a sensitive means for distinguishing between chemically similar substances . . .

The Phoenix line of Automatic Differential Refractometers represents a new concept in automatic refractometry, as they are able to plot refractive index changes in any non-opaque liquid stream, dark or clear, such as a still output or a chromatographic eluate, etc . . . Light from the source labeled M is rendered monochromatic through a series of narrow band pass filters labeled MF, which are mounted in an indexing turret allowing rapid selection and isolation of the wavelength desired. The monochromatic light after passing through the slit S is collimated by a lens system L, and enters the differential cell which is divided into two compartments: one for solution, the other for solvent . . . (*From new 8-page Bulletin R1000 Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila. 40, Pa.*)

FOR THIS LITERATURE CIRCLE 206 ON READER-SERVICE CARD

Pneumatic Temperature Control

Systems used for heating require the addition of moisture to the air, to maintain the proper relative humidity conditions. The relative humidity controller is located either in the space proper or the return air. Pan humidi-



fiers, water sprays, and steam grid humidifying equipment are the most common types. The limited capacity of pan humidifiers makes their use advisable only on installations where moisture requirements are low. Either two-position or proportional action controllers may be used with pan or steam grid humidifiers . . . (*From new 32-page Bulletin M101, Johnson Service Co., 507 E. Michigan St., Milwaukee 1, Wis.*)

FOR THIS LITERATURE CIRCLE 207 ON READER-SERVICE CARD

WRITE YOUR OWN CONTROL-VALVE TICKET!

Check your own control-valve requirements against the above list of ideal features. There's one versatile valve that delivers all of them—a DeZurik cylinder-actuated Control Valve. No other control valve offers so much complete efficiency, such total performance, with the further advantage of non-binding eccentric action. Changeable cam-type positioner makes possible almost any flow characteristic.

You can write just about any control-valve ticket, and DeZurik has the efficient answer. Throttling, on-off, pneumatic, hydraulic or electric actuation, resilient plug-facing or metal-to-metal seating, body-and-plug materials for virtually any application, sizes from 1/2" through 30". DeZurik Control Valves have been "customized" to fit thousands of flow-control situations; they can do the same for you at less cost than less effective valves.

WRITE FOR CATALOG 150 or
for specific recommendations.

DeZURIK Corporation
Sartell, Minnesota
DeZURIK OF CANADA, LTD. Galt, Ontario

CIRCLE 58 ON READER-SERVICE CARD

Features of AUTOTRON NEW Series A579

A579 Series Controls are available with self-contained sensing head as illustrated; with small remote sensing heads and with a wide selection of light sources.

Connecting a capacitor to one of the terminal blocks adds time delay.

Adjustable time delay furnished when specified.

Literature illustrating and describing different models and combinations, also light sources mailed promptly on request.

- Fast Acting — .025 sec. light time, .025 sec. dark time.
- Enclosed Plug-in 10-ampere, DPDT Relay.
- Cad Cell and Transistors replace tubes.
- Transistors protected from transient voltage.
- Cad Cell exceptionally well shielded from extraneous light.
- Latest printed circuit technique.
- Gasket-sealed cast aluminum case.

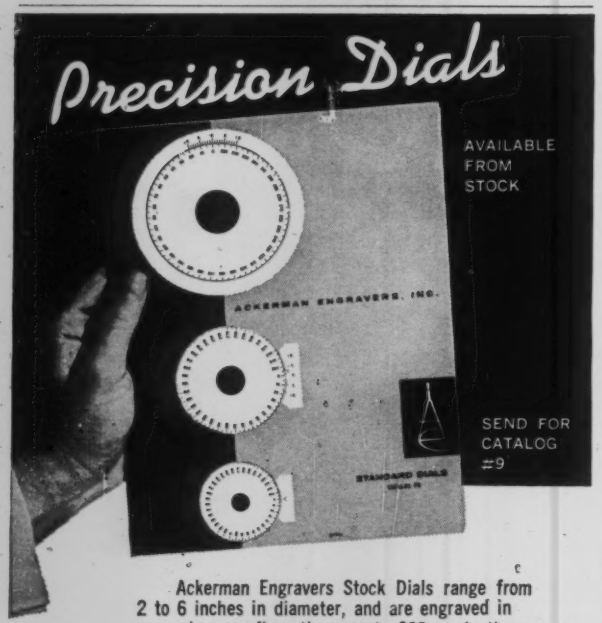
Send for literature

AUTOTRON, INC.

Box 722Q Danville, Ill.

Ph. area code 217, 446-650 TWX DANV Ill 7338

CIRCLE 59 ON READER-SERVICE CARD



Ackerman Engravers Stock Dials range from 2 to 6 inches in diameter, and are engraved in various configurations up to 360 graduations, clockwise and counter-clockwise. Ring dials, drum dials, verniers, knobs, and hubs are also available. A number of finishes all of which meet military specifications can be had.

Whatever your Dial specification, stock or custom consult Ackerman Engravers.

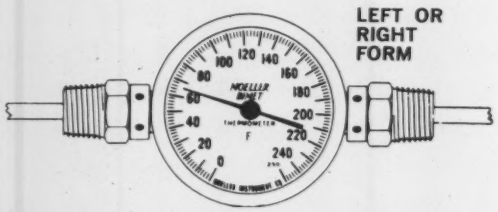
ACKERMAN ENGRAVERS, INC.

43-22 36 St., Long Island City 1, N.Y.

CIRCLE 60 ON READER-SERVICE CARD

Bimetal Thermometers

The Moeller Bimet Dial Thermometer is actuated by a temperature sensitive bimetallic helix which is silicone dampened for pointer stabilization and more rapid heat transfer. Size and material of the helix is determined



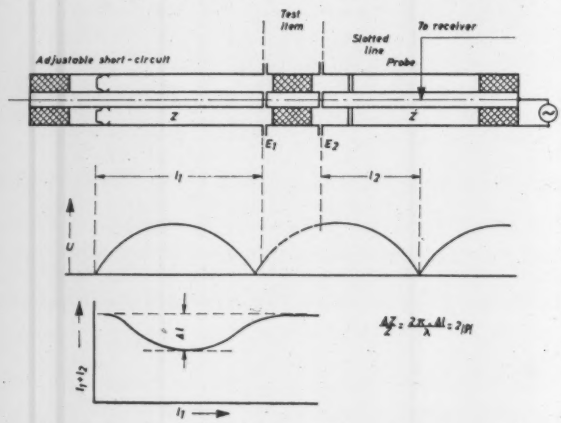
by the stem length and temperature range. As a result of the well-balanced design of the helix, shaft and pointer assembly, the thermometer is a rugged instrument with excellent resistance to vibration without sacrifice of sensitivity. It may be temporarily heated well above its normal range without damage to the sensing element . . .

By designing Bimets with an exclusive ball-joint feature . . . makes it possible to order dial thermometers with stems in almost any angular position . . . The stem projects from the right or left side of the case . . . (*From new* 12-*page Catalog* 225*D, Moeller Instrument Co., Richmond Hill* 18, *N. Y.*)

FOR THIS LITERATURE CIRCLE 208 ON READER-SERVICE CARD

Reflection-Coefficient

The most accurate method of determining small reflection coefficients of four-terminal networks is the node-shift method described by Weissfloch. With modern means on accuracy of 0.15 to 0.2 per cent is obtainable



. . . The discontinuity, represented by a four-terminal network with defined contact planes, E_1, E_2, is inserted between a short-circuited coaxial line of variable length and a slotted line providing indication of standing waves. The short-circuited length of line is varied in small lengths (l_1) until a complete half-wave length is traversed. Simultaneously the shift of the voltage node is observed on the slotted line, in corresponding increments of length (l_2). The lengths of $l_1 + l_2$ are plotted as a function of l_1 to obtain the node-shift curve . . . (*From new* 12-*page Bulletin "Dezifix, Sexless Flange-type Connector," Rohde & Schwarz Sales Co., Inc., Box* 275, 111 *Lexington Ave., Passaic, N. J.*)

FOR THIS LITERATURE CIRCLE 209 ON READER-SERVICE CARD

Sanborn® 7-Channel FM tape system for $6800* complete

uses interchangeable FM and direct record/reproduce electronics entirely contained in 7″ x 19″ panel space

COMPARE PERFORMANCE, PRICE PER CHANNEL

Here is the ideal combination of high performance *and economy* in a 7-channel, 4-speed system that meets IRIG Telemetry Standards. *Versatility* is another advantage. The Model 2000 system uses interchangeable Sanborn FM or direct record/reproduce electronics — all solid-state, in 7″ of panel space — and you can have any combination of direct and FM channels simply by changing circuit cards. Recording capability may be extended beyond the system's minimum input levels through the use of Sanborn "850" and other compatible amplifiers.

The Model 2000 Magnetic Data Recorder has four speeds and uses standard ½-inch tape on 10½-inch reels. All controls are on the front, and several convenience features are included: an integral FM Alignment Meter that eliminates the need for electronic counters, an automatic squelch, a tape footage counter, and provision for using one channel for flutter compensation.

Complete details are available from Sanborn Sales-Engineering Representatives in principal cities throughout the U. S., Canada and foreign countries.

**Price FOB Waltham, Mass., in Continental U. S. A.; subject to change without notice. State and local taxes must be added where applicable.*

(Specifications subject to change without notice)

SPECIFICATIONS

Input ± 2.5 V into 10,000 ohms, single ended, adjustable.

Output ± 2.5 V into 1,000 ohms or more, single ended; level, position adjustable.

Bandwidths (Max)

Speed	*FM*	*Direct*
3¾″/sec	0-625 cps	50-6,250 cps
7½″/sec	0-1,250 cps	50-12,500 cps
15″/sec	0-2,500 cps	50-25,000 cps
30″/sec	0-5,000 cps	100-50,000 cps

(100% modulation on FM = ± 40% carrier deviation)

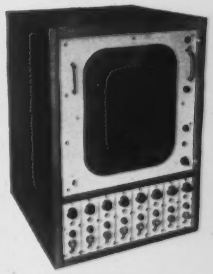
Linearity Maximum error due to nonlinearity: 0.2%.

Drift ± 0.5% of full scale for 10 V power line change, 10°C ambient temperature change, or for 24 hours at constant power line voltage and ambient temperature.

Signal-to-Noise Ratio (Min)

Direct: 40 db at all speeds.

FM: 40 db RMS at 30″/sec and 15″/sec; 35 db RMS at 7½″/sec; 33 db RMS at 3¾″/sec.

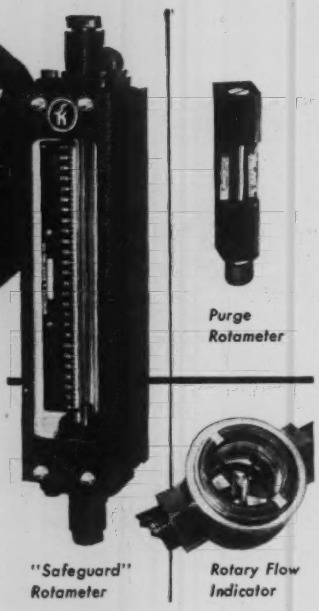


Readout, as well as input monitoring during magnetic recording, may be provided by this compatible 17-inch, 8-channel Viso-Scope or other Sanborn monitoring instruments, or by direct writing systems.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

CIRCLE 61 ON READER-SERVICE CARD

FAST DELIVERY *on Rotameters and Flow Indicators*



Purge Rotameter

"Safeguard" Rotameter

Rotary Flow Indicator

SK makes a complete line of Rotameters and Flow Indicators. For quick delivery the company stocks popular types and sizes. If you need action fast, contact us stating your requirements. We'll let you know if a stock item is available and, if not, what we can do to expedite delivery. Call us at Cornwells Heights, Bucks County, Pa., "MErcury 9-0900" or contact us by TWX, "Cornwells, Pa., 69." Ask for the INSTRUMENT DIVISION.

SK's complete line of Rotameters for accurately measuring fluid rate of flow and Flow Indicators for indicating flow are briefly described in Bulletin M-1. Write for your copy.

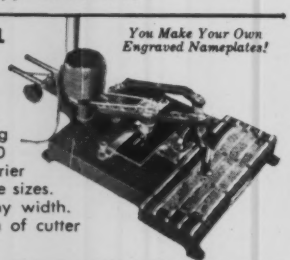
Schutte and Koerting COMPANY
INSTRUMENT DIVISION
2225 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.
CIRCLE 62 ON READER-SERVICE CARD

● KEEP YOUR OPERATING COSTS WHERE THEY SHOULD BE!
● ELIMINATE DELAYS!

GREEN *Pantograph Engravers*

MODEL D-2 HEAVY-DUTY 2-DIMENSIONAL
Pantograph for milling, drilling and engraving.
Vertical adjustment of copy table automatic with Pantograph. Features: unobstructed on 3 sides to take large work; micrometer adjustment for depth of cut; ball bearing construction throughout; spindle speeds up to 26,000 rpm for engraving or machining; vertical range over 10"; ratios 2 to 1 to infinity — master copy area 26" x 10".

PORTABLE 40-POUND BENCH MODEL
Here is a speedy, economical 2 or 3-dimensional engraver used by thousands of dollar-conscious companies. It features 5 positive, accurate pantographic ratios; ball bearing spindle with 3 speeds up to 14,000 rpm. Is supplied with one copy carrier that accepts all standard master type sizes. Will actually work up to 10" by any width. Height of pantograph and position of cutter are continuously adjustable.



You Make Your Own Engraved Nameplates!

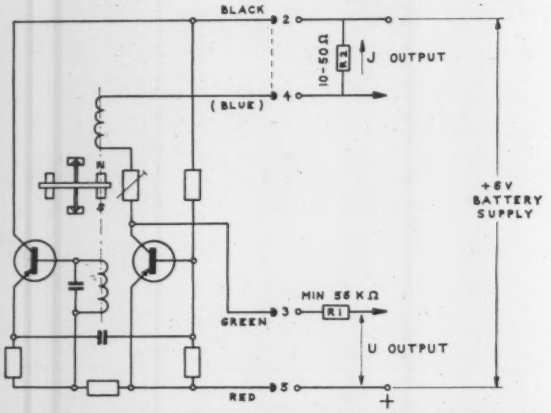
MODEL D2-201 PNEUMATIC ATTACHMENT
for use with Model D2 Pantograph Engraver to rapidly drill holes in printed circuits by tracing templates. Drills as many as 100 holes per minute. Equipped with foot switch; spindle air cylinder; regulating valve and pressure gauge; filter and oiler. It's ready to use as soon as it's attached to an air compressor.

Write or call for full details and prices.

GREEN INSTRUMENT COMPANY, INC.
Dept. 83, 295 Vassar St., Cambridge 39, Mass. Tel. ELiot 4-2989
CIRCLE 63 ON READER-SERVICE CARD

Timing Pulse Generator

The two sections . . . one mechanical, one electronic . . . of this DC pulser reciprocally control one another to produce a low frequency periodic pulse output with a stabilized precision of 3 x 10^{-5} per 24 hours in the



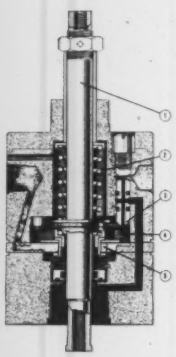
range of 4 to 10 pulses per sec . . . A spring balance wheel starts to oscillate automatically when current is switched on. Two fixed coils are disposed coaxially above and below a permanent magnet set in the rim of the balance wheel, parallel to its axis of rotation. The current induced in one of the coils when the magnet passes triggers a transistorized amplifier. The magnetic field induced in the other coil by the amplifier acts on the magnet and gives the balance wheel an impulse to maintain its oscillation. The coaxial arrangement of the coils results in two simultaneous control pulses independent of the direction of approach of the magnet. Output pulses, two for each complete oscillation, are therefore almost equally spaced . . . (*From Bulletin* 501, *Presin Co.*, 2014 *Broadway, Santa Monica, Calif.*)

FOR THIS LITERATURE CIRCLE 210 ON READER-SERVICE CARD

D/R Actuator

The actuator is so designed that it can be mounted on the yoke to provide either direct (air-to-push down) or reverse (air-to-push up) actuator stem action . . .

Series 7500 Positioner is a pneumatic, force balance device designed for integral mounting on these valves to insure positioning accuracy . . . The positioner is mounted on top of the diaphragm case on valves assembled for direct action; between the diaphragm case and yoke on valves assembled for reverse action . . . An increase in signal pressure actuates the double diaphragm assembly to diminish the force exerted on the flapper by the spring. The flapper moves to cover the nozzle, increasing positioner output pressure to the actuator. The resultant actuator stem movement causes the positioner stem to compress the positioner spring until the force exerted by it on the flapper balanced the opposing force of the double diaphragm assembly . . . (*From new* 12-*page Bulletin* 308, *Mason-Neilan, Div. of Worthington Corp., Norwood, Mass.*)

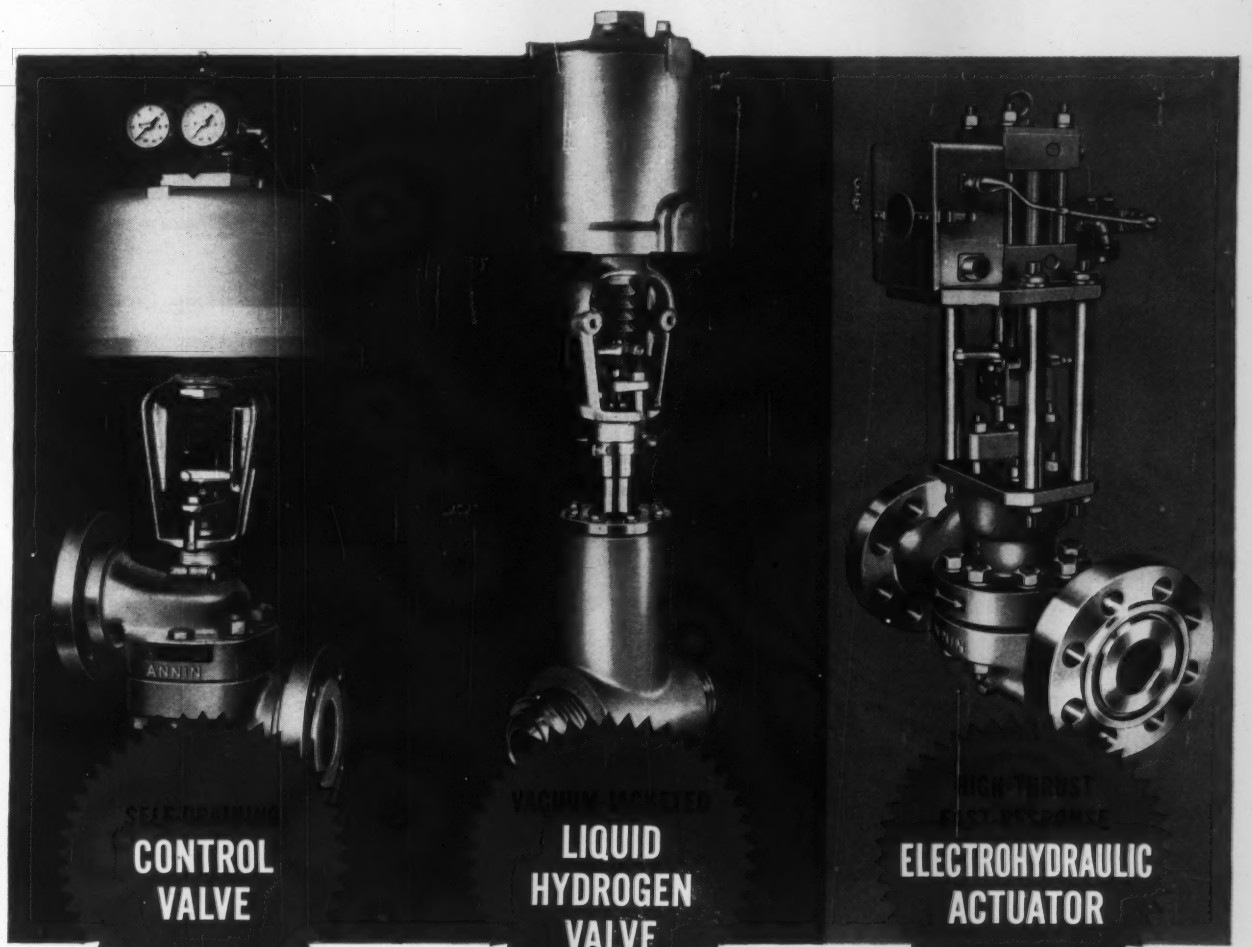


FOR THIS LITERATURE CIRCLE 211 ON READER-SERVICE CARD

Continued on page 2232

ANNIN VALVES ...offer advanced designs for fields that are moving ahead!

MILITARY AND PROCESS CONTROL APPLICATIONS



In design and operational capability, Annin control valves begin where others leave off! The reason? Annin has always set the pace in fluid flow control ever since it pioneered split body, single seat construction, and showed control engineers how to achieve precise, positive control automatically. Typical of Annin's leadership today in fields requiring advanced design are the three new valves pictured above: Model 1900 Self-draining Control Valve, designed to handle toxic or corrosive fluids and slurries which must be flushed out of the system periodically; Model 1700 Vacuum Jacketed Cryogenic Valve, for the precise control of liquid hydrogen in missile ground support systems; and Series 20,000 Electrohydraulic Actuator, characterized by high thrust and extremely fast response, ideal for polyethylene reactor let-down valves, fuel blending systems, aero/space test stands, and with turbine by-pass valves for power plants.

Send for complete technical bulletins on these and other Annin products

ANNIN VALVES

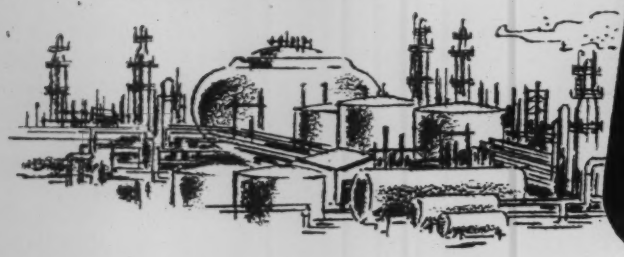
Products that work for your profit

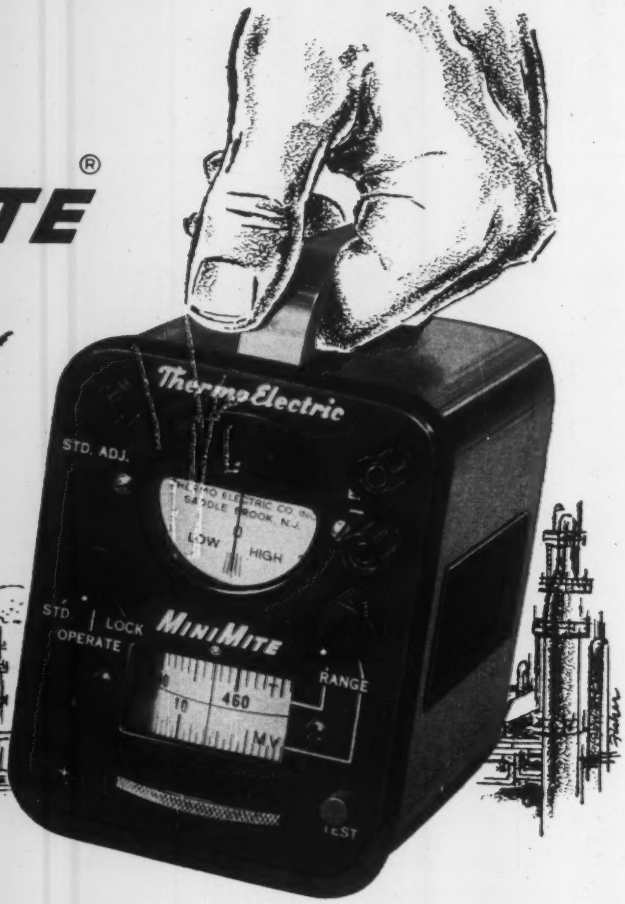
THE ANNIN COMPANY
1040 S. Vail Avenue • Montebello, California

CIRCLE 64 ON READER-SERVICE CARD

Portable MINIMITE® Goes Anywhere

for Accurate Temperature – Millivolt Measurement





Take accurate temperature-millivolt measurements wherever you go—laboratory, plant or field—with the rugged, compact, portable "MiniMite". Moderately priced, the "MiniMite" (null-balance potentiometer pyrometer) weighs just 3½ lbs., measures just 4″ x 5″ x 6″, provides ¼ of 1% of scale accuracy with a long 23.6″ double range scale. Widely spaced scale graduations facilitate easy, accurate reading. A standard flashlight battery provides standardization.

Measure Temperatures Directly

Connected to a thermocouple, the "MiniMite" provides accurate temperature indication, anywhere. It is used for standard checking and calibrating procedures. Automatic cold-junction compensation is built-in.

Measure Millivolts Directly

Any transducer with a dc millivolt output can be checked quickly with the "MiniMite".

Calibrate Other Instruments

The "MiniMite" can be used to check or calibrate potentiometer or millivoltmeter type recorders, indicators, controllers, easily—with little or no extra equipment.

Special Design

An adaptation of the "MiniMite", called the Airline "MiniMite", is made to quickly check dynamic performance characteristics of jet engine exhaust temperatures, E.G.T. spread or average and calibrate cockpit indicators. It also can be used as a source of variable dc millivolts.

72 Double Range Scales

Range Scales for the "MiniMite" can measure temperatures from minus 450°F. to plus 3200°F. with all standard thermocouple materials, including various Platinum-Rhodium combinations. Many millivolt scale ranges are available. The double range scales are available with two different thermocouple calibrations, combinations of a temperature and millivolt range, or a single temperature or millivolt scale.

Operation is Easy

Anyone can obtain accurate readings quickly. Connect the "MiniMite" to a sensing element or instrument to be checked, standardize and adjust for readings.

You can have delivery of the model, and range scales you need promptly, many are carried in stock.

Write today for information—Instrument section 64-12

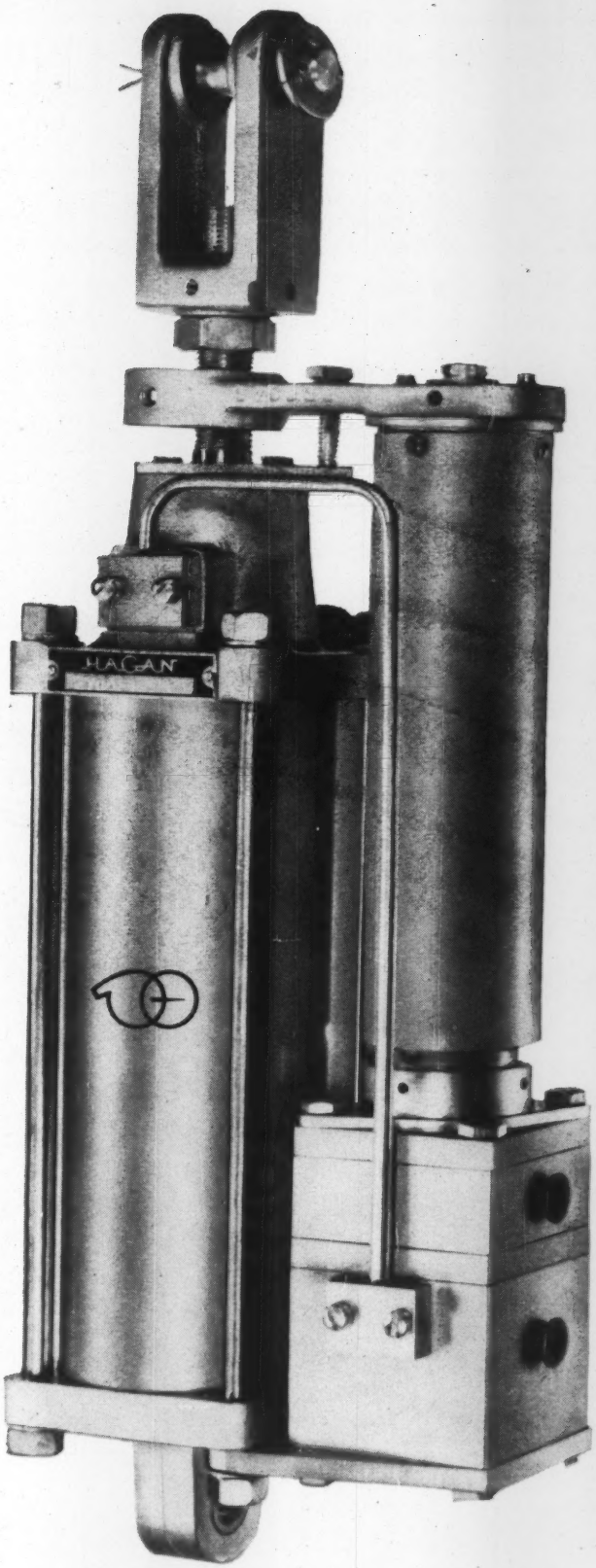
Thermo Electric

Temperature Measuring Systems and Components

20 YEARS

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

CIRCLE 65 ON READER-SERVICE CARD



Newest member of Hagan's complete Power Positioner line–

HAGAN 2½" x 5" POWER POSITIONER

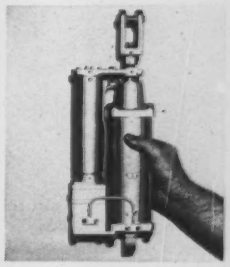
This little gem is new, but already over 500 of them are at work in a number of applications where accuracy, speed and power are requirements.

The 2½" x 5" has the following specs:

Positioning accuracy	1%
Frequency response	1.0 cps @ 10% peak to peak input 0.5 cps @ 5% peak to peak input
Full stroke time	Less than 2 seconds
Power air	100 psig max., 45 psig min.

It also shares these common characteristics with the rest of the Hagan line: design simplicity, rugged construction, minimum maintenance requirements and high positioning stability. Unit is compact, easily adapted for valve mounting and large port areas minimize plugging problem on poor air systems.

For complete information, write or phone for specifications sheet TP22550.



HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PENNSYLVANIA

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

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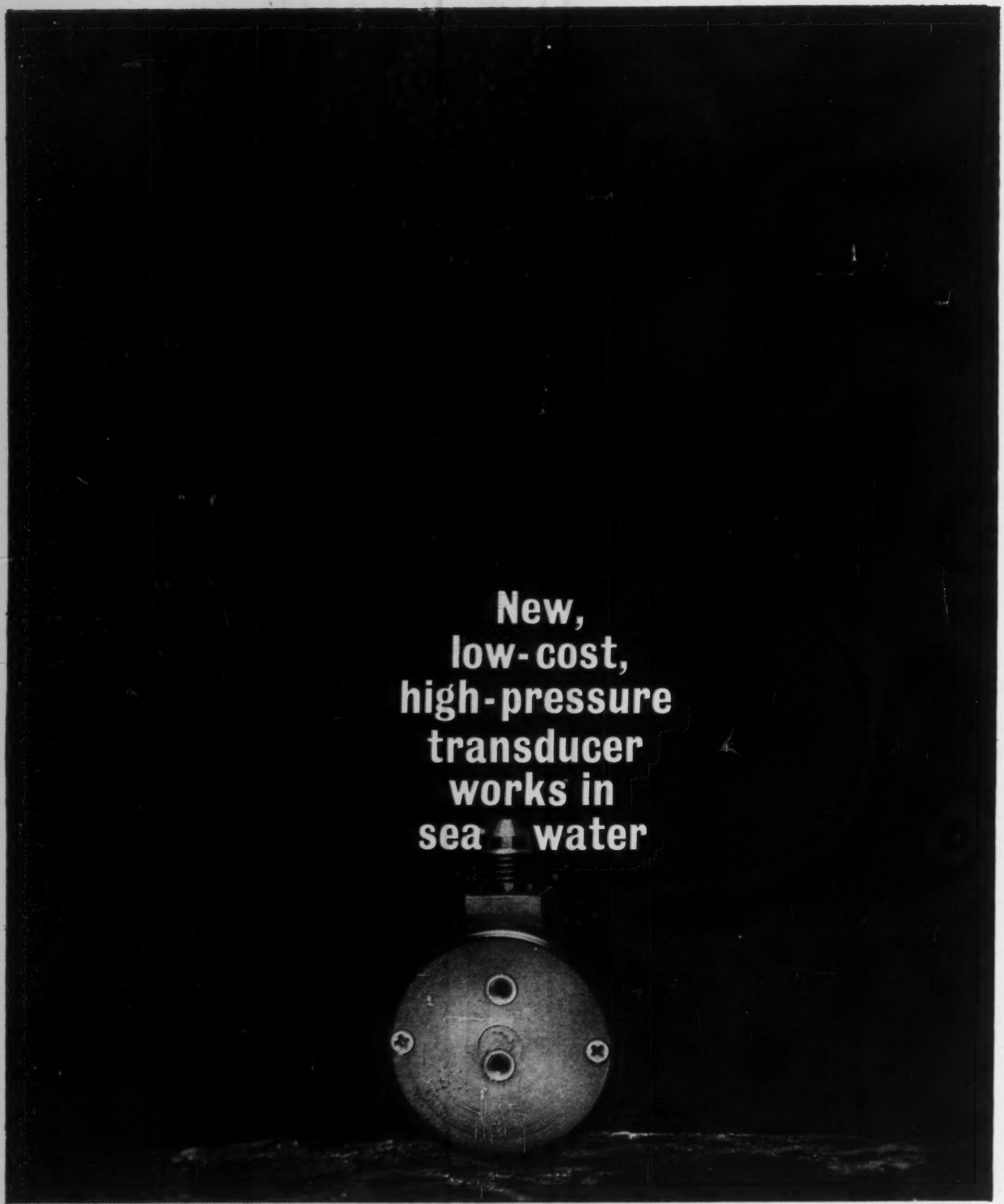
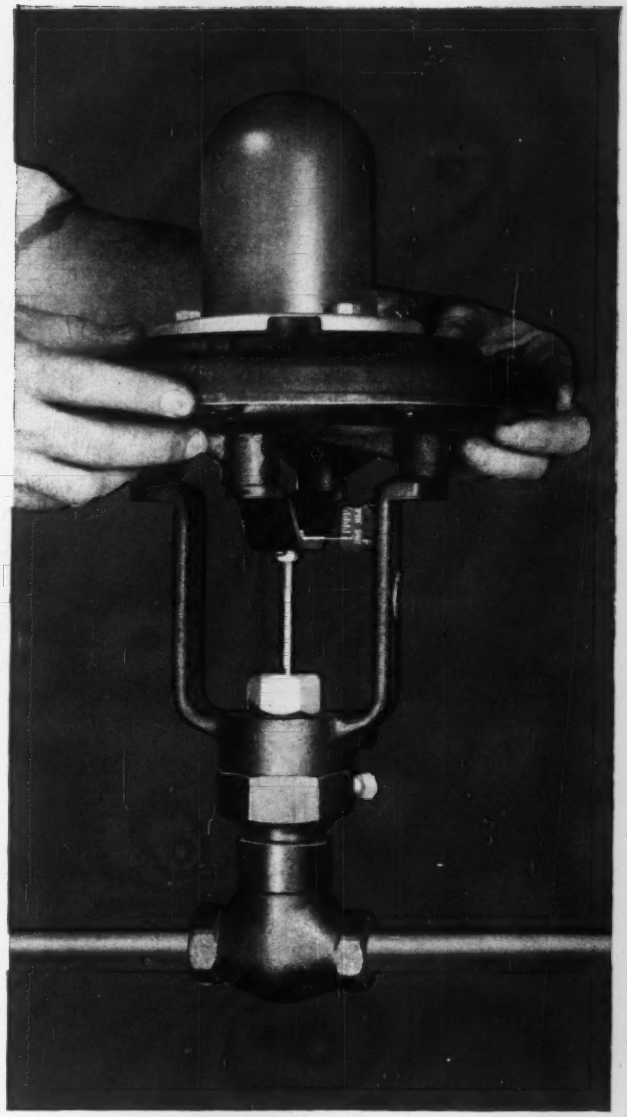


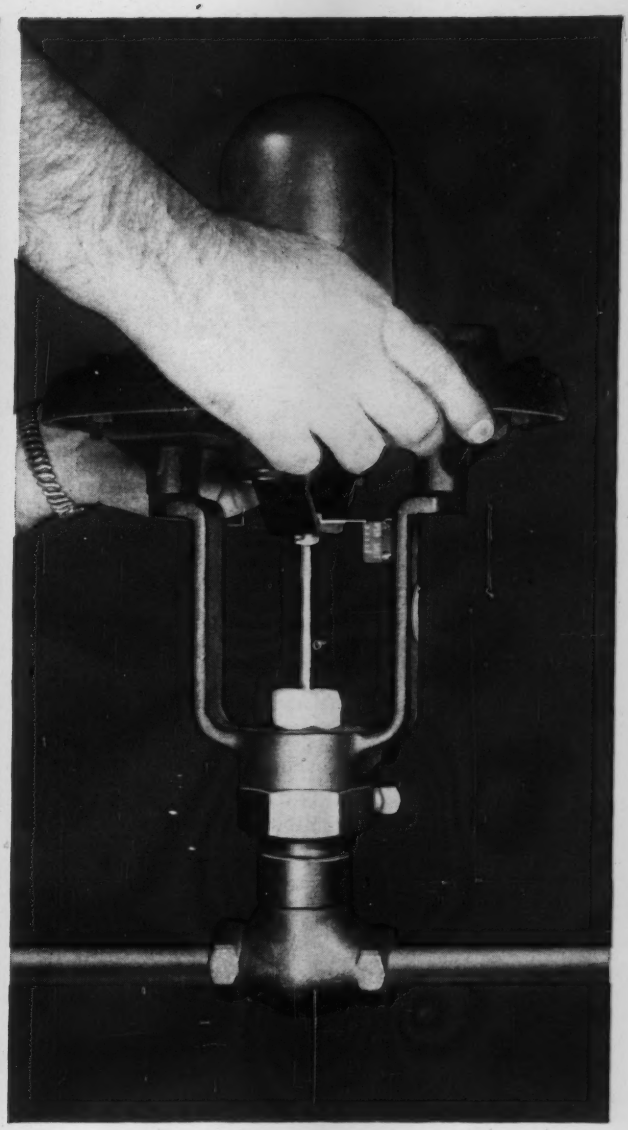
A unique "Z"-flexure® amplification makes DeJUR's new HPT-10 miniature high-pressure transducer the lightest, smallest, most-economical precision measuring instrument of its type anywhere. A simplified, frictionless mechanism, the "Z"-flexure eliminates the need for bearings, pivots, rubbing-point linkages and other devices which adversely affect reliability. This new design—which is continuously operable in sea water and other corrosive and non-corrosive media—also achieves remarkable dynamic balance and accuracy in harsh temperature, vibration and acceleration environments. For immediate delivery (at low cost) in production quantities, and for complete details, write today to Instruments Division, DeJUR-Amsco Corporation, Northern Boulevard at 45th Street, Long Island City 1, New York.

YOU'RE ALWAYS SURE WITH **DeJUR** ELECTRONIC COMPONENTS

Manufacturers of precision electronic equipment for over 35 years

CIRCLE 67 ON READER-SERVICE CARD





LOOK HOW EASY IT IS TO REVERSE THE ACTION OF A FOXBORO CONTROL VALVE!

air-to-open . . . air-to-close — one valve for the job of two

Unbolt the motor casing and rotate it 90°; rebolt and shift air connections — that's all you do to reverse the operation of a Foxboro control valve. Takes just a few minutes — without touching valve body or process piping — without employing special tools or skills.

Foxboro reversible motors are especially suited for needle valves, Saunders-type valves, and other control valves having non-reversible bodies. They're also used with Foxboro Stabilflo* Valves — the original valves with equal percentage flow characteristics and wide 50 to 1 rangeability.

Foxboro control valves with their quick-reversible valve motor, are an exclusive Foxboro development. They're perfect for pilot plant operations and other processes frequently "juggled." Types and materials to meet any process requirement.

Write for detailed bulletins today. The Foxboro Company, 4612 Neponset Avenue, Foxboro, Mass.

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

CIRCLE 68 ON READER-SERVICE CARD

The Best Miniature Soldering Iron In The World . . .

Precision
MINIATURE SOLDERING IRON

110-115 volts
No Transformer
Weighs 1 ounce
6½ inches long

$4.35 EACH IN LOTS OF 6
Tips extra

Precision . . . the best low wattage soldering iron made . . . has sealed element to maintain constant temperature around 626°F.

- Ultra-flexible 3-wire cord . . . grounded . . . 50 megohms between element and tip protects components and operator.
- Bright "safety" yellow handle stands more than 1000°F . . . stays cool.
- Easy slide-on tips . . . stay hot under production speeds . . . made of tungsten-copper alloy; nickel or iron plated; diameters from 3/32" to 3/16"; spade or chisel ends.

Irons furnished less plugs; heavy-duty 2 or 3-pronged plugs available.

Write:
M. M. NEWMAN CORPORATION, Dept. 4
79 Clifton Avenue, Marblehead, Massachusetts

CIRCLE 69 ON READER-SERVICE CARD

MODEL 9B PYROTEST
The Most Versatile Portable Potentiometer Made

- Checks any thermocouple-actuated instrument
- Guaranteed accuracy— ⅛ of 1%.
- 9 interchangeable, direct-reading scales

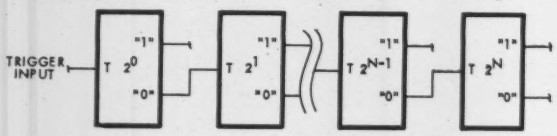
Pyrotest is the only portable potentiometer that can check any thermocouple-actuated indicator, controller, or recorder. It comes with 6 thermocouple scales and 3 MV scales—as easy to change as phonograph records. Scale length of over 4 feet, with high resolution to match. Pyrotest is so accurate, it's used as a standard in the lab . . . so versatile and rugged, it's used as an all-purpose tool everywhere in the plant. Only $315.00, fob Indianapolis. Write for free Bulletin 9-B.

TECHNIQUE
TECHNIQUE ASSOCIATES
A Division of Duncan Electric Co., Inc.
1413 CORNELL • INDIANAPOLIS 2, INDIANA

CIRCLE 70 ON READER-SERVICE CARD

Digital Logic Modules

The transistorized digital logic modules are complete and compact plug-in logic elements . . . Each module contains from 1 to 16 complete and separate circuits (depending upon the type of circuit). The circuits provide

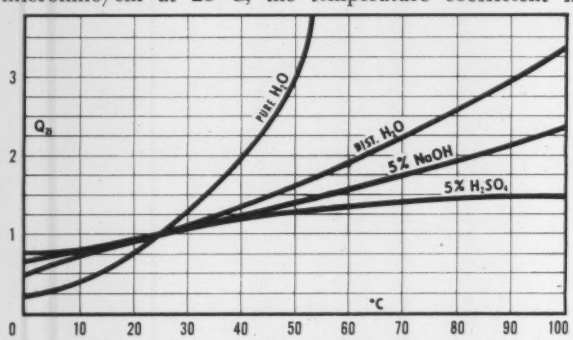


dc to 100 kc, 1 mc, 6 mc, and 12 mc switching rates (depending upon the model) in a variety of configurations. Logic functions such as AND gating, OR gating, frequency division, storage, scanning, forward and backward shifting or counting, and arithmetic operations can be performed at speeds up to 12 mc with the IEC digital logic modules. Special functions are obtained from a combination of standard and specialized circuits on a single card . . . The modules can be arranged in endless combinations, limited only by the ingenuity of the logic designer . . . (*From 68-page handbook "Digital Application Notes," including chapters on Basic Logic Design Principles, Boolean Algebra, Graphic Symbols, Logic Modules, and Circuit Configurations, Interstate Electronics Corp. Subs. of Interstate Engineering Corp., 707 East Vermont Ave., Anaheim, Calif.*)

FOR THIS LITERATURE CIRCLE 212 ON READER-SERVICE CARD

Temperature Compensation in Conductivity Measurement

The conductivity of ultra pure water changes very sharply with rise of temperature, increasing at a rate of more than 5% per degree C. At a conductivity of 1 micromho/cm at 25°C, the temperature coefficient is



only half this value and there is little change with water quality beyond this point. In the region between 0.055 and 1 micromho/cm at 25°C, the temperature coefficient varies with conductivity and with the nature and concentration of the foreign ions. As a consequence, no single temperature compensator can adequately cover both ultra pure water and water of substantially poorer quality. This is shown graphically in figure where there are plotted for several different very dilute water solutions and for ultra pure water itself, the curves related Q, the ratio of conductivity at temperature T°C to the conductivity at 25°C, against temperature. A temperature compensator incorporating the characteristics of one of these could not be accurately applied to the others . . . (*From new 8-page Form 21644-D, Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, Essex Co., N. J.*)

FOR THIS LITERATURE CIRCLE 213 ON READER-SERVICE CARD

CIRCLE 71 ON READER-SERVICE CARD→

SIX NEW DIGITAL INSTRUMENTS

for measuring voltage, ratios, and resistance with **all-electronic speed and reliability**

...including the world's first full-**5-digit solid state** digital voltmeter / ratiometer

They're all-electronic! No moving parts. No contacts to clatter or wear. All the inherent advantages of solid state circuitry: speed, ruggedness, reliability and coolness.

They're fast! 20 readings per second, average. High speed eliminates reading delays due to cycling caused by decreasing voltages.

They're reliable! Carefully selected components, rigorous testing programs and accelerated aging—equivalent to 100 hours of actual operation—combine to give EITRONIC instruments an unequalled mean-time-to-failure figure.

They're accurate! Production EITRONIC instruments provide a true, absolute DC accuracy of 0.01%; AC 0.1%.

They're automatic! Virtually eliminates operator error. Even decimal point placement and polarity indication are automatic.

They're human engineered! Unique readout tilts to 3 positions, is easy to read whether instrument is used on a bench, at eye level or high in a rack. Modular construction permits exhaustive testing during assembly, facilitates trouble shooting and field servicing.

They're available now! Your EI field engineer has a new 8-page folder which gives complete specifications on the EITRONIC Series. Ask him for a copy today.

Another significant breakthrough in digital instrumentation from

Electro Instruments, Inc.

8611 BALBOA AVENUE, SAN DIEGO 11, CALIFORNIA

***Engineers:** Challenging opportunities now available. Contact Mr. Harvey Fleming.*

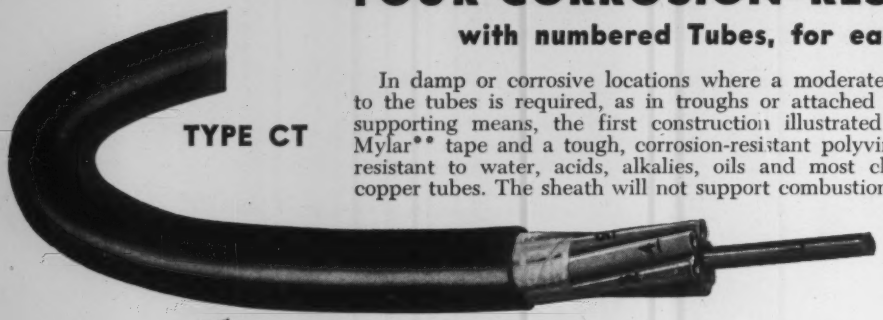
CRESCENT ARMORED MULTITUBE*

FOUR CORROSION-RESISTANT TYPES

with numbered Tubes, for easy identification

TYPE CT

In damp or corrosive locations where a moderate degree of mechanical protection to the tubes is required, as in troughs or attached to sheltered building surfaces as supporting means, the first construction illustrated is recommended. It employs a Mylar** tape and a tough, corrosion-resistant polyvinyl chloride thermoplastic sheath, resistant to water, acids, alkalies, oils and most chemicals, applied over CABLED copper tubes. The sheath will not support combustion.

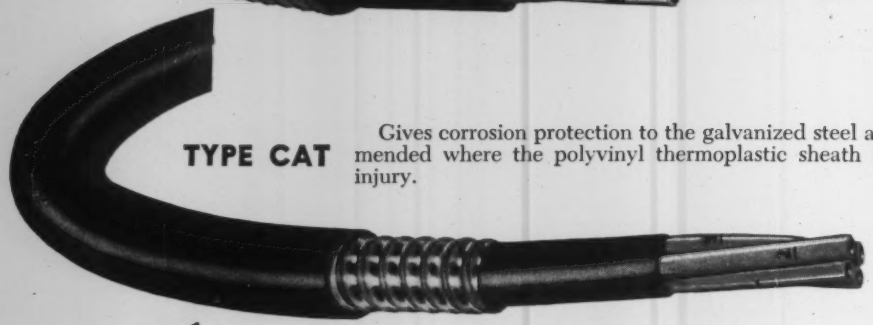


TYPE CTA

Gives corrosion protection to the tubes, and the galvanized steel armor protects the tubes and polyvinyl thermoplastic sheath from mechanical injury during and after installation. Recommended for direct burial in concrete or pulling into underground conduits.

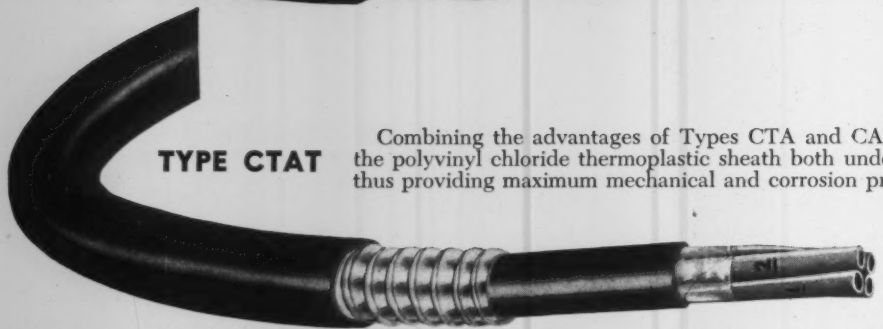
TYPE CAT

Gives corrosion protection to the galvanized steel armor as well as the tubing. Recommended where the polyvinyl thermoplastic sheath will not be subject to mechanical injury.



TYPE CTAT

Combining the advantages of Types CTA and CAT, the fourth type illustrated has the polyvinyl chloride thermoplastic sheath both under the armor and over the armor, thus providing maximum mechanical and corrosion protection.



All these corrosion-resistant types can be furnished with copper, aluminum and polyethylene tubes, and up to 37 tubes.

Plastic Coated Single Tubes, copper or aluminum, should be used to give corrosion protection to all single lines up to the final tube fitting, where trouble from corrosion may occur.

Send for Bulletin 960-A giving complete information and engineering data

THIS PRODUCT IS LICENSED UNDER U. S. PAT. NO. 2,578,280

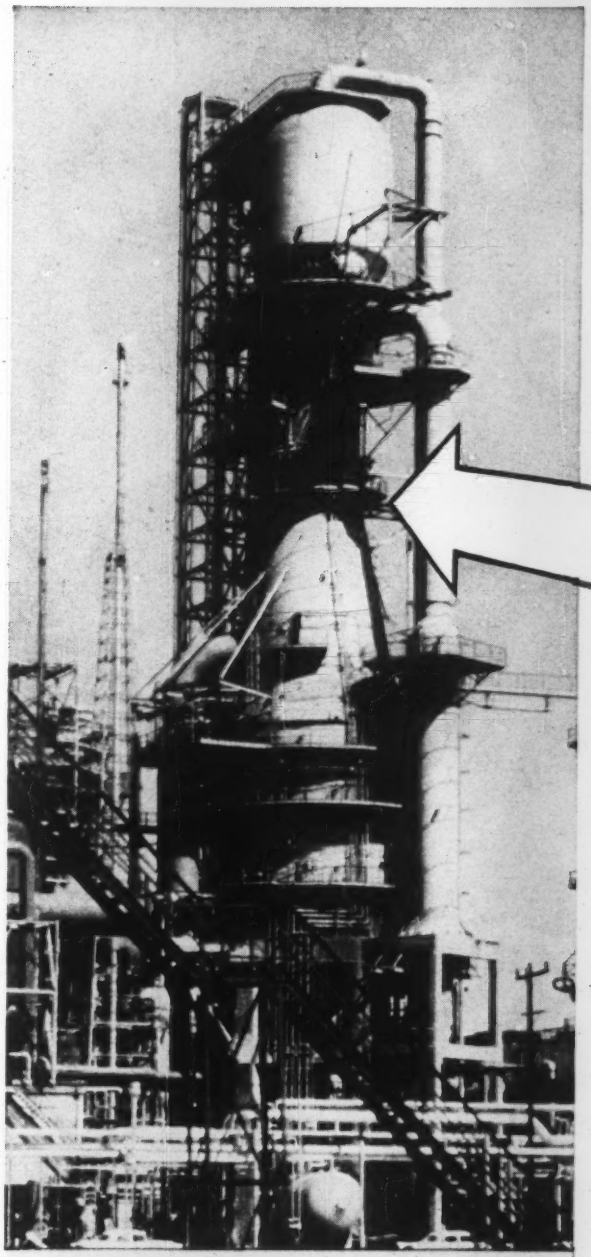
CRESCENT INSULATED WIRE & CABLE CO., INC.

TRENTON, NEW JERSEY

*Reg. Trade Mark **Dupont Reg. T.M.

CIRCLE 72 ON READER-SERVICE CARD

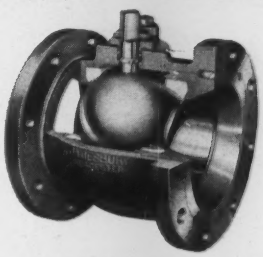
At *CRITICAL* Valve Control Points



...You Get Dependable Operation with

jamesbury "Double-Seal"™ BALL VALVES*

*PATENTED.



FIRE SAFE VALVING IN REFINERIES

The Jamesbury "Double-Seal" FIRE SAFE Ball Valve (Type DZ) has been accepted for use in the hydrocarbon industry because of its outstanding performance. In the event of fire — and the loss of the valve's soft seats, secondary metal seats provide effective shut-off of the fluid flow.

It stands to reason that a valve that performs outstandingly under adverse conditions can be relied on to give trouble-free performance under less severe conditions. That has been one of the big reasons, at least, for the success of Jamesbury "Double-Seal" Ball Valves. Proved dependable at *critical* valve control points, these valves have gone into industrial plants everywhere to control nearly all types of media flow.

There are many exclusive features about the Jamesbury "Double-Seal" Ball Valve which contribute to its excellent performance record. For example, there's Jamesbury's patented lip seal; there are no internal springs; you get leak-tight stem seals; operators are mounted integral with the valve. For further information about Jamesbury "Double-Seal" Ball Valves, contact your nearest stocking distributor — or write us direct.

WIDE RANGE OF SIZES:

Screwed end ¼" through 3".

Flanged 150# series ½" through 12" — 300# ½" through 8".

Larger sizes on request.

VARIETY OF MATERIALS:

Valves in 303 and 316 Stainless Steel, Alloy 20, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Interchangeable seats and seals in Teflon, Teflon compounds, Nylon, Buna-N, Neoprene, Hypalon and natural rubbers. Type DZ: Ductile Iron and Carbon Steel, Standard.
Other materials on request.

Ask For Jamesbury Fluid Services Guide

JAMESBURY CORP.

649 Lincoln St., Worcester, Mass.

DISTRIBUTORS IN PRINCIPAL CITIES

QUARTER TURN OPERATION
HIGH FLOW CAPACITY
ZERO LEAKAGE

NO LUBRICATION REQUIRED
MINIMUM MAINTENANCE
MANUAL OR POWER OPERATION

As Versatile As Industry Itself!

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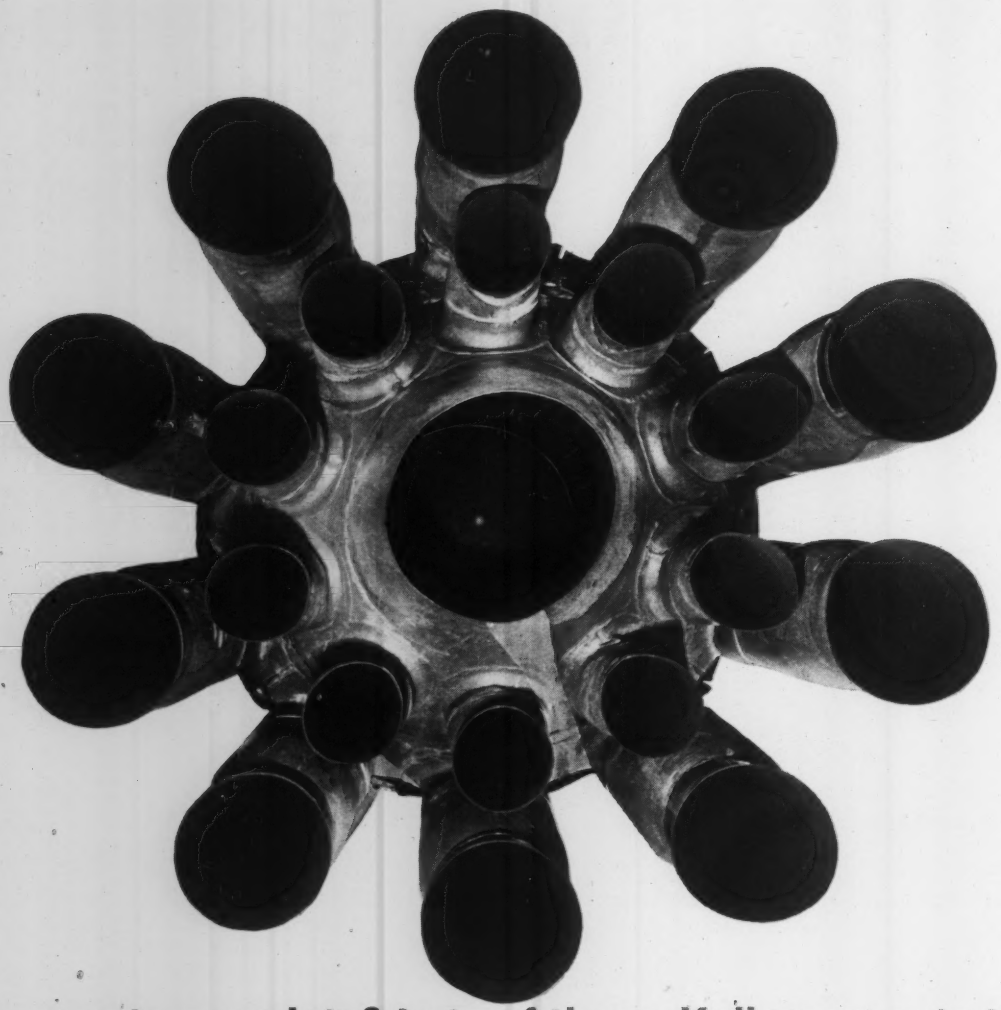
CIRCLE 73 ON READER-SERVICE CARD



what!—counters on jets? Lots of them. Kollsman KOLLSMAN INSTRUMENT CORP. puts them there. And Veeder-Root supplies Kollsman, providing jet pilots with direct read-out—immediate indication of the vital data necessary for controlling aircraft travelling at jet speeds. Can Veeder-Root help your performance? Better find out. Write to Instrument Section, Veeder-Root Incorporated, Hartford 2, Connecticut. **count on . . . Veeder-Root**

Modern thrustmeter—one of many special instruments which uses Veeder-Root counting ingenuity—shows pilots the power conditions necessary for safe take-off.

CIRCLE 74 ON READER-SERVICE CARD

The Counter Reads

ISSUES

0	0	4	0	8

and thereby registers the end of thirty-four years of service by *INSTRUMENTS AND CONTROL SYSTEMS* to users of instruments and equipments for measurement, testing, calibration and control. The staff of *I&CS* sends its fond greetings for a Happy New Year to every one of its precious readers.

THE LAST ISSUE of a year is a fitting place to pause and review the past; the best guide to the future is the past.

In 1961 the following fields were surveyed for our readers:

Electrical Measurements and Standards
Temperature Measurement and Control
Pressure and Force Measurement and Control
Flow Measurement and Control
Timing and Programming
Telemetering Techniques
Data Processing Systems
Data Storage
Boolean Symbolic Logic
Numerical Control Techniques
Weight Measurement and Control
Analytical Instrumentation
Optical Instrumentation
Recording Techniques
Power Supplies (series begins in this issue)

In 1962 we plan to expand each of these fields for our readers; every technique not yet discussed will be analyzed and reported.

To readers who missed the beginnings of these integrated series of powerful articles, much of the material is available in either book or handbook form. Most of the articles in each issue of *Instruments & Control Systems* is more than an article —it is a part of an integrated series of articles that lives for years in book form after its appearance as an article. This is a high tribute to the articles in *I&CS*.

The staff of *I&CS* wishes every reader a Happy New Year, and rededicates itself to bringing him the best, the most important, the most educational and the most useful in measurement and control techniques.

M. H. ARONSON . . . editor

Milton Aronson

Power Supplies

JAY MONROE
Tensor Electric Development Co., Inc.

Precision A-C Supplies

The most common technique for calibrating a-c voltmeters is use of a comparison standard meter. However, use of a precision standard a-c reference supply that gives known voltages has advantages in convenience. Waveform factors always must be kept in mind when making a-c measurements.

THE MOST COMMON METHOD of calibrating working-level a-c voltmeters is by comparison with a standard rms-responding meter, usually a thermocouple or dynamometer type that has been calibrated on dc. A low-distortion source usually is used to deflect both the standard meter and the meter under calibration.

The moving-pointer dynamometer and thermocouple meters are highly developed devices that will always be used widely. Some of the standard meter's advantages are simplicity and reliability.

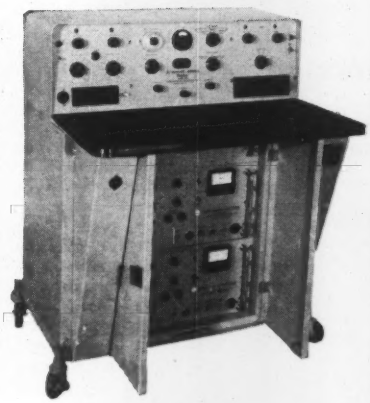
There have been three recent developments in moving-pointer meters that have improved their status even further. One is the bifilar-type suspension (Greibach)* meter that is much less susceptible to damage from overloads. Second is scale expansion available in (Sensitive Research "Incrementer" and Greibach "Selective Expansion") folded-scale meters. The third is incorporation of a built-in standard cell and circuitry to permit self checking of the meter (Sensitive Research "THATCH").

However, there are a number of inconveniences and uncertainties in using a standard comparison meter with a thermocouple or dynamometer element, including: (1) The standard meter requires recalibration; (2) the standard meter is subject to burnout; (3) the analog scale is subject to parallax and interpolation errors; (4) the standard meter is delicate and subject to damage in handling, (5) an external power source is required, (6) thermocouple standard meters may require temperature corrections, (7) setting the standard meter to a desired deflection is a slow process, possibly involving tapping the meter and slow manipulation of the power supply controls to allow for the meter time-constant.

These inconveniences can be reduced by use of an a-c reference source. These devices, unknown six years ago, now offer digital setting and self-contained oscillators. They may soon achieve a popularity comparable to their d-c counterparts (such as Epsco VR-607, the KIN TEL model 301 and Radiation's standard supply).*

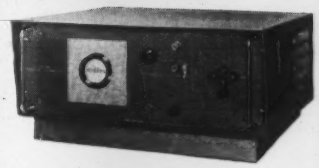
*See *INSTRUMENTS AND CONTROL SYSTEMS*, September 1959, page 1377, for article on bifilar-type suspension.

*See *INSTRUMENTS AND CONTROL SYSTEMS*, September 1959, pages 1357-9, and April, 1960, pages 638-9 for surveys of precision d-c sources.



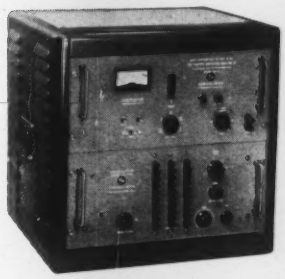
RFL 1967

TENSOR 5890



ELIN VC-555

BALLANTINE 420



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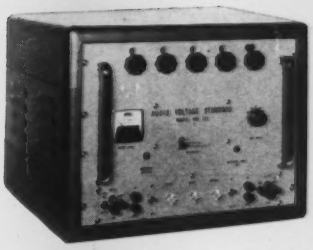
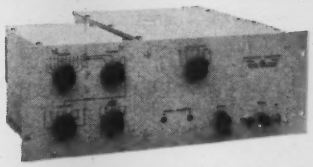
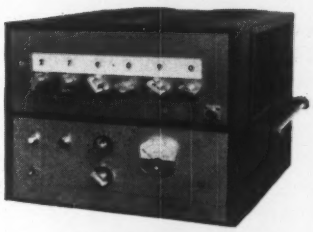


HOLT AVS 321



HEWLETT PACKARD 738AR



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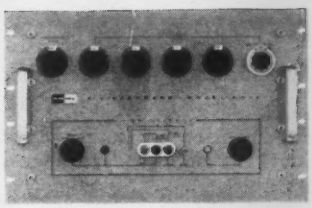

KIN TEL 601A

TABLE 1—A-C REFERENCE SUPPLIES AND FEATURES

MAKE	MODEL	PRICE	ACCURACY	CIRCUITRY	OUTPUT
BALLANTINE	420	$ 365	0.5%* (0.25% with chart)	Oscillator stabilized by barretter bridge in feedback loop providing voltage stability for months.	0-10 v direct reading in four ranges, continuously variable (dc, ac rms, ac peak-to-peak) at 1000-cps ± 1%. Drives high impedance, such as VTVM, scope, etc.
TENSOR	5890	$ 495	0.25%	Zener diode used in a voltage-sensitive bridge, manually balanced on an internal null indicator against external highpower source, ac or dc.	Four ranges (0-0.1, to 0-100 v) at 60 cps, continuously variable by multiturn dial. 10 ma at 100 v. Accessories: 1000 vac, dc (currents to 1A) accessory available; 25 cps to 20 kc output with external source.
ELIN	VC 555	$ 795	0.10%*	RMS-sensitive bridge in feedback loop provides stabilizing signal.	VC-555: 5, 50 or 500 v rms at 400 or 5000 cps. Floating output; zero effective impedance; 1 amp at 5 v.
HEWLETT PACKARD	738AR	$ 895	0.25%*	RC oscillator with AGC and stabilized amplifier.	Twenty-five steps from 300 μv to 300 v, dc or ac, rms or peak, at 400 cps; frequency can be varied from 5 cps to 10 Mc with accessories. Drives high impedance, such as VTVM, scope, etc.
KROHN-HITE	LDS-115	$2250	Must be used with calibrated standard*	Stable oscillator followed by stabilized amplifier.	0-115 v continuously adjustable, in five ranges; frequency can be selected from 20 cps to 20 kc, also continuously variable; 50-watt output.
HOLT	AVS-321	$3670	0.1% ± 2mv from 1-300v; ± 0.25% from 300 to 1000v over 30 days at any frequency, any voltage, any load (to 30 w).	Zener reference compared to rectified output to control oscillator amplitude.	Continuously variable from 1 v to 1000 v with resolution of 1 mv. 4 decade switches plus vernier. 30 w output; 30 cps to 10,000-cps output with external oscillator; 60 cps with internal oscillator.
KIN TEL	601A	$4500	0.10%	Unsaturated mercury-cadmium cell d-c reference compared with rectified sample of output.	Tenth-volt steps plus multiturn potentiometer provides better than 0.1 millivolt resolution from 1 to 501 v rms at 60, 400, and 1000 cps. Floatin, guarded output; 25 va output.
ROTEK	146A	$5900	0.035%	Zener reference compared to the rectified output voltage and used to control the oscillator amplitude.	One-mv steps to 511.110 v at 50, 60, 400 and 1000 cps output ± a fixed variation around each frequency; 10 va output; 1000 v ac output with accessory.
RADIO FREQUENCY LABORATORIES	1967	$6950	0.05% at 50, 60, 400 cps; 0.1% above 400 cps	Standard cell used in a thermal transfer circuit to adjust the a-c supplied by means of an all-electronic servo.	Ten ranges, each divided by 150 steps, from 0-1.5 v at 2 va to 0-1500 v at 15 va; frequency is variable, from 50 to 2400 cps. Current ranges to 75 amps.

* Calibrated with an external reference as there is no internal reference.

The modern a-c reference supply can contain the following four elements:

1. A standard voltage reference, such as a Zener diode or a standard cell.

2. An accurate digitally-controlled ratio transformer or resistive divider.

3. A self-contained low distortion a-c source capable of sufficient output to deflect the meter under calibration.

4. A method of minimizing loading errors, such as a cathode follower or feedback amplifier.

Table 2 lists some available a-c reference supplies with various accuracies. Accuracy poorer than 0.5% would not be useful; better than 0.035% is not yet available. Undoubtedly, others will be introduced.

It should be noted that some supplies have a built-in reference, while others do not; those that do not require calibration against an external reference. The supplies in Table 1 which do not have such an internal reference are noted by an asterisk in column 4 (accuracy).

Regardless of which circuit arrangement achieves the greatest acceptance, a-c reference supplies of proven stability will be used increasingly for meter calibration because dialing a known voltage is more convenient than measuring an unknown one with a comparison standard meter.

Measuring ranges	Compensator ranges	Max. limits of error
0-16.1 millivolt	0-1.1 millivolt	0.01 millivolt
0-16.1 millivolt	0-5.5 millivolt	0.02 millivolt
0-80.5 millivolt	0-1.1 or 0-5.5 millivolt	0.05 millivolt

Rubicon Model 2745 portable potentiometer. Price: $425, F.O.B., Philadelphia. Write for Specification Sheet RS 2745a.

This potentiometer has permanent accuracy*

It's possible to achieve impressively high potentiometer accuracy in one-shot tests under ideal laboratory conditions. And that is exactly how the advertised accuracies of some instruments are attained.

Not so with Rubicon potentiometers. These are instruments you can count on for consistently stable, reproducible accuracy for their entire life. This accuracy is created by careful engineering and superb craftsmanship, not by premium-priced gimmicks.

A case in point is our Model 2745 portable potentiometer, shown above. Its exceptionally narrow limits of error will apply every time you use the instrument . . . today and years from now. Incidentally, this is the only portable potentiometer that extends reference junction compensation to the entire range of sub-zero measurements. It enables you to make a continuous series of measurements above and below the table reference temperature, without readjusting the compensator or reversing the leads. And its built-in Pointerlite galvanometer is sensitive enough to permit balancing to ± 0.002 millivolt in circuits up to 15 ohms.

This fine potentiometer and the entire Rubicon line of precision measuring instruments are available through Honeywell sales offices across the nation. MINNEAPOLIS-HONEYWELL, Ridge Avenue at 35th St., Philadelphia 32, Pa.

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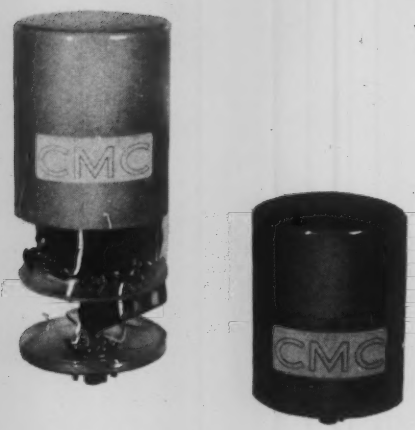

JAY T. NICHOLS
Control Methods Co.

Zener-Regulated Power Supplies

Use of Zener diodes with shunt and bridge regulator circuits gives supplies of high stability

ZENER regulators can be used to give a highly stable current source for both industrial and laboratory use. Fig. 1 is a typical plot of diode current versus voltage for both polarities. As the negative anode voltage is increased, the reverse current is almost zero until the Zener breakdown voltage is reached. The reverse current then increases greatly for small increases in reverse voltage. Before breakdown the resistance is very high—in the order of hundreds of megohms; in the breakdown region it is in the order of ohms. This breakdown is not destructive and one can cycle into and out of this breakdown condition indefinitely as long as the unit is kept within its thermal limitations.

Simple regulator circuits of both the shunt and bridge type are available.

Shunt Regulator

In the shunt regulator circuit the diode is placed in shunt with the load and acts as a current overflow device with a particular potential bias (Fig. 2). When the voltage level on the diode is low, almost all the current is carried by the load. Above the Zener voltage, an increase in voltage (V_s) will increase current carried by the diode, with the output voltage remaining constant. In Fig. 2 the regulating voltage, V_D, is less than the voltage on the load resistor. The voltage to the load is:

$$V_R = V_D + i_D R_D \qquad (1)$$

For best shunt regulation, R_D should be small; the smaller the better.

Bridge Regulator

The bridge regulator uses a silicon diode voltage regulator to bias the output of an otherwise balanced bridge (Fig. 3). If the bridge is balanced, incremental changes in the bridge supply voltage have no effect on the bridge output current.

Analysis of Errors

Silicon diode regulators do have temperature coefficients. The temperature change exhibited by single-alloy junction regulating diodes is increasingly negative for units below approximately five volts, and increasingly positive for diodes which regulate at voltages above five volts. It is possible, therefore, to select diodes having a zero temperature change and regulating at about five volts. But the size of the temperature change is not as important as the accuracy with which we know the change.

Perfect performance can be only approached because of (1) deviation of component behavior from ideal and (2) the necessity of production tolerances on component parameters.

The effect of variations in supply voltage can be reduced by using a bridge-type regulator, and the temperature coefficient of the diode can be compensated by using a positive-temperature-coefficient resistor in the bridge load. Fig. 4 shows a circuit using both shunt and bridge regulation stages. In this circuit the maximum errors at 33°C with components having production tolerances are as follows—(1) temperature change of the second-stage (bridge)

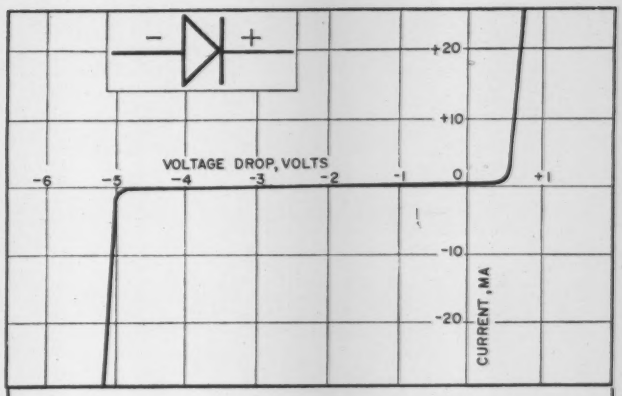

FIG. 1. CURRENT-VOLTAGE relationship of a typical silicon diode regulator. Zener region is shown at left.

diode—±0.056%, (2) resistance tolerance of temperature-compensating resistor in series with load—±0.008%, (3) tolerance for temperature change of 400-ohm bridge resistor—±0.0008%, (4) variation of measuring-bridge resistance with temperature—0.025%, (5) tolerance for temperature change of 200-ohm bridge resistor and the non-compensating portion of R_L—±0.003%, (6) tolerance for temperature change of 16K bridge resistor—±0.003%.

The square root of the sum of the squares of all computed thermal errors at 33°C gives the most probable error. In this case deviation of the diode temperature coefficient from the mean largely determines the result of ±0.06%, or approximately ±0.0018% per C°.

Experiments were performed on a group of nine 0.010-amp constant-current supplies using the circuit shown in Fig. 4. All nine are well within the 0.003% per C° tolerance set as maximum allowable change of output with temperature. However, the computed most probable error is 0.00175% per C°.

Some test models have been run for a period of months with their output bucked against standard cells. The difference voltage from this experiment was recorded on a multipoint potentiometer. Both the Zener supplies and the standard cells were subjected to test temperature excursions. The three units showed shifts of +0.04, −0.025%, respectively, over a period of 3000 hours.

A constant-current supply designed along the lines presented in this paper is now a proved industrial device. Production units have seen over a year of field service in a wide variety of factory ambient conditions. Field failure incidence has been less than ½%.

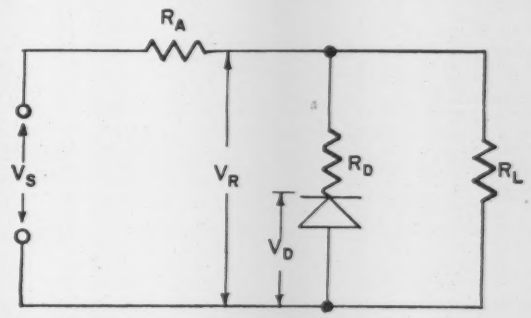

FIG. 2. SHUNT regulator circuit.

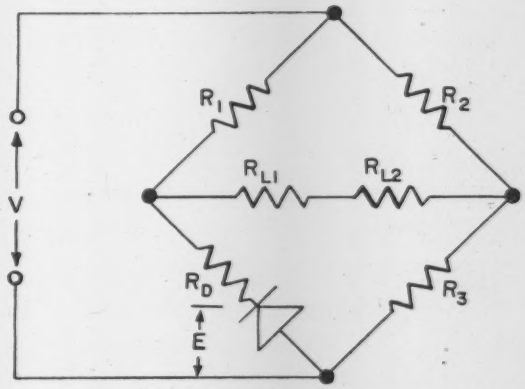

FIG. 3. BRIDGE-TYPE regulator circuit.

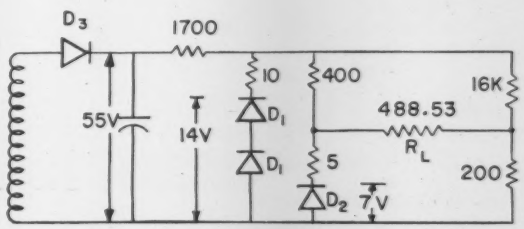

FIG. 4. SUPPLY using half-wave rectification followed by shunt and bridge-type regulator circuits. R_L comprises load plus temperature-compensating resistor in series.

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From its multi-option printed circuit board to its numerous interchangeable components, the Model 536 Temperature Controller spells *versatility*. ON/OFF or proportioning control . . . dial for set point adjustment mounted externally or internally . . . expanded scales for precise temperature adjustment — the 536 offers all these advantages! Five standard temperature ranges from −50 to +600°F . . . separate potentiometer with graduated dial and knob for remote temperature adjustment . . . capacity of 10 amp/110 VAC and 5 amp/230 VAC . . . these choices are also available to you. *And you pay only for the options you need!*

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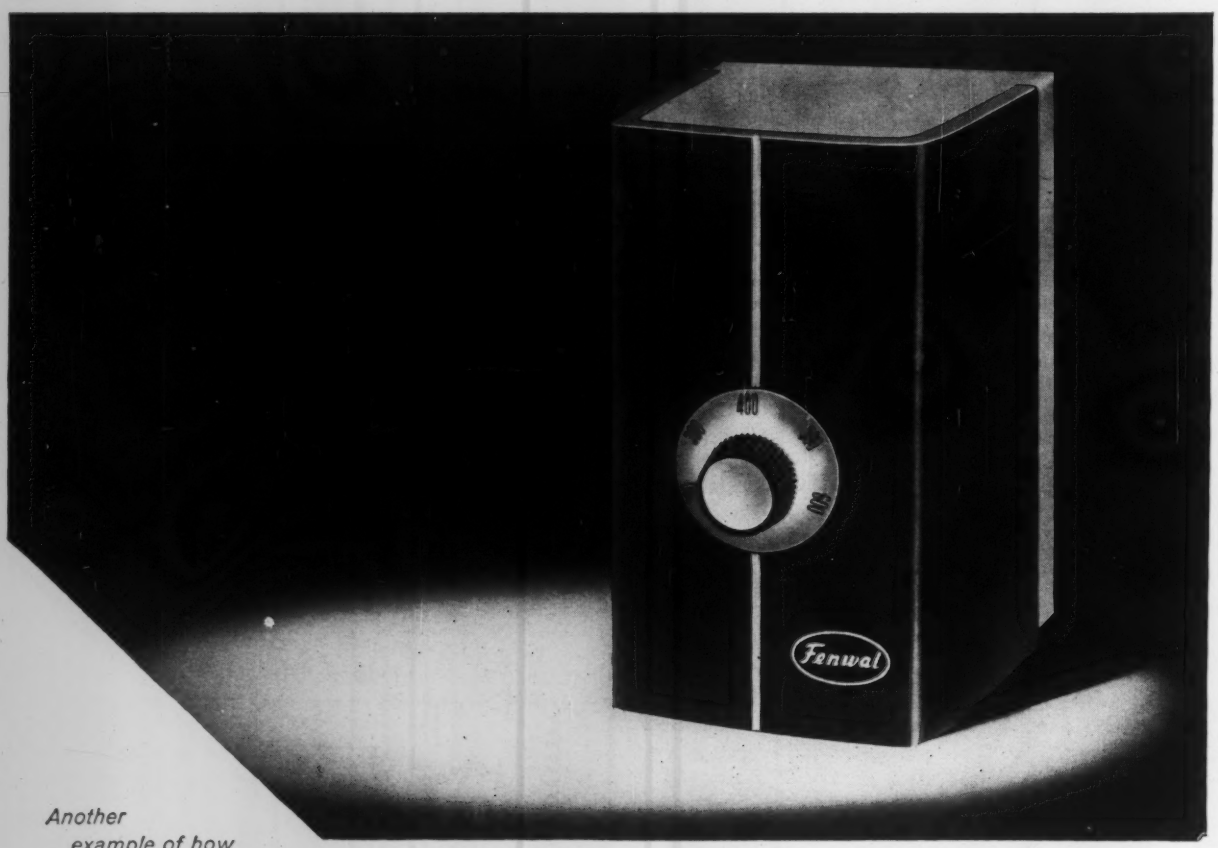

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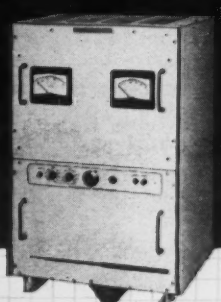

Dynamic Regulation ±0.5 volt

Ripple 1 Millivolt

Recovery Time 50 Microsec.

Output Impedance 1 Milliohm

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STATIC REGULATION — LINE & LOAD: ±0.05%.

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DUAL A-C INPUT: 220/440 volt, 3-phase, 60 cps.

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STANDARD FEATURES: 10-turn voltage adjustment pot., voltmeter, ammeter, input contactor, pilot light.

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EMERGENCY POWER SYSTEMS

Alternating-current power supply switches to storage battery for emergency power with no interruption to load in event of power line failure. Uninterrupted power supplies (UPS) are motor/generator sets running continuously to avoid start-up interruption should power fail.

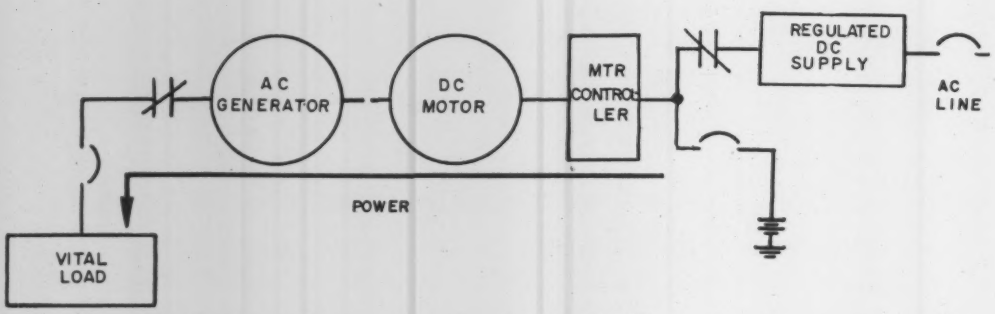


FIG. 1. LINE POWER is rectified in Types I and II to drive a motor and generator and to keep a battery charged. When line fails, the contact at right opens and the battery keeps the motor and generator running to supply the load.

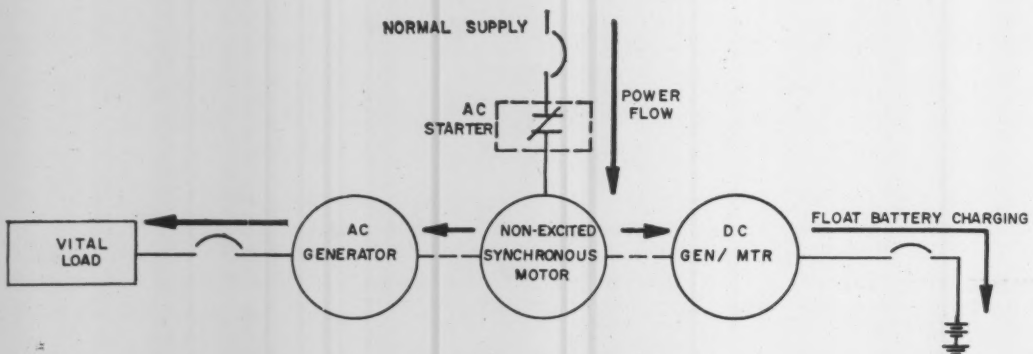
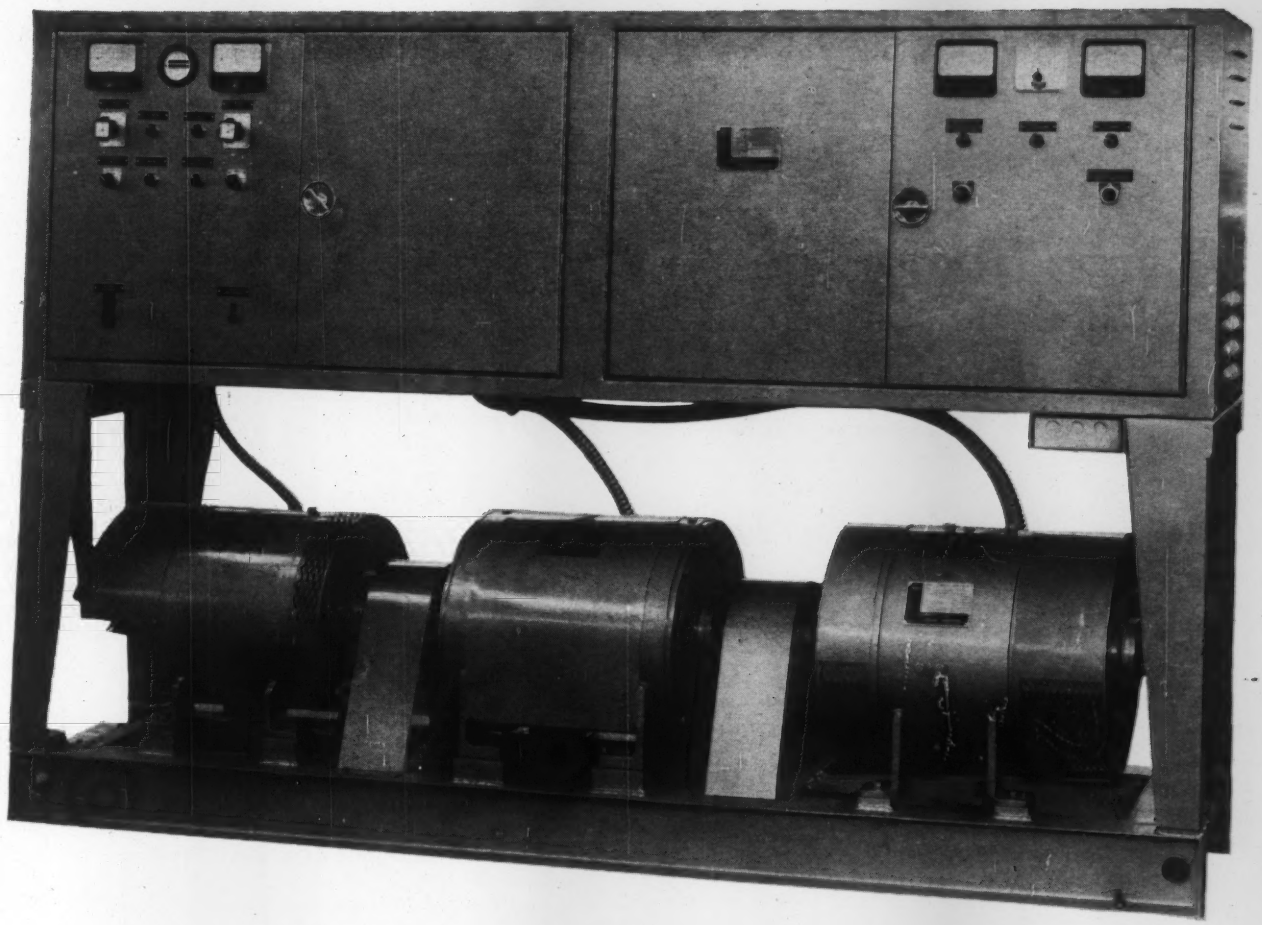


FIG. 2. TYPE-III SYSTEMS (and Type-IV) do not use a regulated d-c supply. An a-c motor, driven by the a-c line, drives both the main a-c generator and a battery-charging d-c generator, as shown by arrows. Latter becomes a d-c motor that drives the a-c motor in event of power failure.



EMERGENCY alternating-current power supply systems have been developed in several basic types, each with a specific field of application. Each of these Uninterrupted Power Systems (UPS) provide for transition from normal to emergency operation with not even momentary loss of power to the load circuit, and with small voltage and frequency transients.

The basic principle in each UPS is that a d-c motor and a-c generator run continuously, supplying the load during normal operation. When line power fails, a standby battery keeps the motor and generator at speed, maintaining power to the load. Thus there is no delay, or interruption, as is required to bring a motor/generator set up to speed in conventional standby power devices.

Fig. 1 shows the Type-1 two-element system. Normally the a-c generator, driven by the d-c motor, supplies the load. Power is supplied to the d-c motor from the regulated d-c power supply, which also supplies battery charging current. In event of line failure the battery drives the d-c motor, which never stops or is interrupted.

The Type-II two-element supply is similar except that the load is supplied jointly from the UPS and the line during normal operation. That is, the a-c generator of the UPS operates in parallel with the normal power source. The amount of power delivered to the load by each power source can be adjusted between the limits of approximately 10% to 90%. This system insures continuity of power to a vital load in the event of voltage loss from *either* the normal power supply or the UPS. However, in event the normal power supply is short circuited, a voltage transient occurs, the severity of which is function of the kind and magnitude of the fault condition in the normal power supply.

Type-III systems (Fig. 2) are three-element systems which include an a-c motor driving an a-c generator, and a d-c machine which functions normally as a battery charger, as shown by the arrows. All three shafts are coupled mechanically to rotate as one. Under emergency operation the d-c machine functions as a motor, driving the a-c generator.

Type-IV UPS systems are similar to Type III in that the load is supplied by the line during normal operation. In normal operation the a-c machine operates as an excited synchronous motor driving the d-c machine, which is acting as a battery-charging generator. The load is supplied entirely by the line. Upon failure of line power, the synchronous motor disconnects from the normal power source and functions as a voltage-regulated a-c generator. It is driven by the d-c machine operating as a d-c motor powered by the battery. As in Type-II systems, short circuits of the normal power supply produce some speed and voltage transients.

Line Voltage and Current Regulation

AL RING
Electric Regulator Corp.

THE REGOHM REGULATOR can regulate a-c or d-c output voltage of a power source within 2% (1% on special order) despite changes in line voltage, load current, or input frequency. Voltage and current regulation to ± 2%, with changes in frequency from 45 cps to 1000 cps, changes in temperature from −20°C to + 75°C, changes in power factor from 1.0 to 0.7 lagging, and with the shock and vibration normally found in portable and mobile operation, can be provided. Response time is less than three cycles with 60-cps inputs.

Fig. 2 shows the principle of operation. The sensing coil attracts the armature and causes it to pivot against a reference spring. The armature thus varies its position with changes in coil energy. As the armature pivots it increases or decreases resistance in the controlled circuit, thus correcting for the error sensed by the sensing coil.

Applications

The output voltage can be connected directly to the load, or it can be stepped up or down through a potential transformer and then connected to the load. Fig. 2 shows the basic use as a voltage regulator.

When the output of the basic circuit is connected to a transformer followed by rectifiers and filtering, it becomes a regulated d-c power supply (Fig. 4).

For current regulation (Fig. 3), sensing coil can be placed in series with the load. It can either regulate for constant current in the load, or prevent excessive currents from flowing in the load. Unlike a fuse or breaker which only blows and disconnects the load, this current limiter continues to operate, holding the load current within safe limits. The basic current-limiting circuit can provide constant-current d-c supplies or current-limited d-c supplies. Applications include constant-current control of airport lighting, constant torque from a servo motor, etc.

Two or more sensing circuits can be used—one for voltage regulation and another for current limiting. Such a combination (connected into a transformer rectifier) provides a d-c supply with constant regulated voltage until a maximum value of current is reached, after which the current will be limited at the maximum value. These are desirable characteristics for battery charging.

Another use is as a reference and control element for high-power devices. The basic regulator circuit can be used at light loading to control the windings of a saturable reactor or magnetic amplifier. This type of circuit has been successfully used in supplies and battery chargers providing kilowatts of regulated power.

Standard units are available for a-c inputs with frequencies of 50 to 450 cps (special units for 25 to 1000 cps are available).

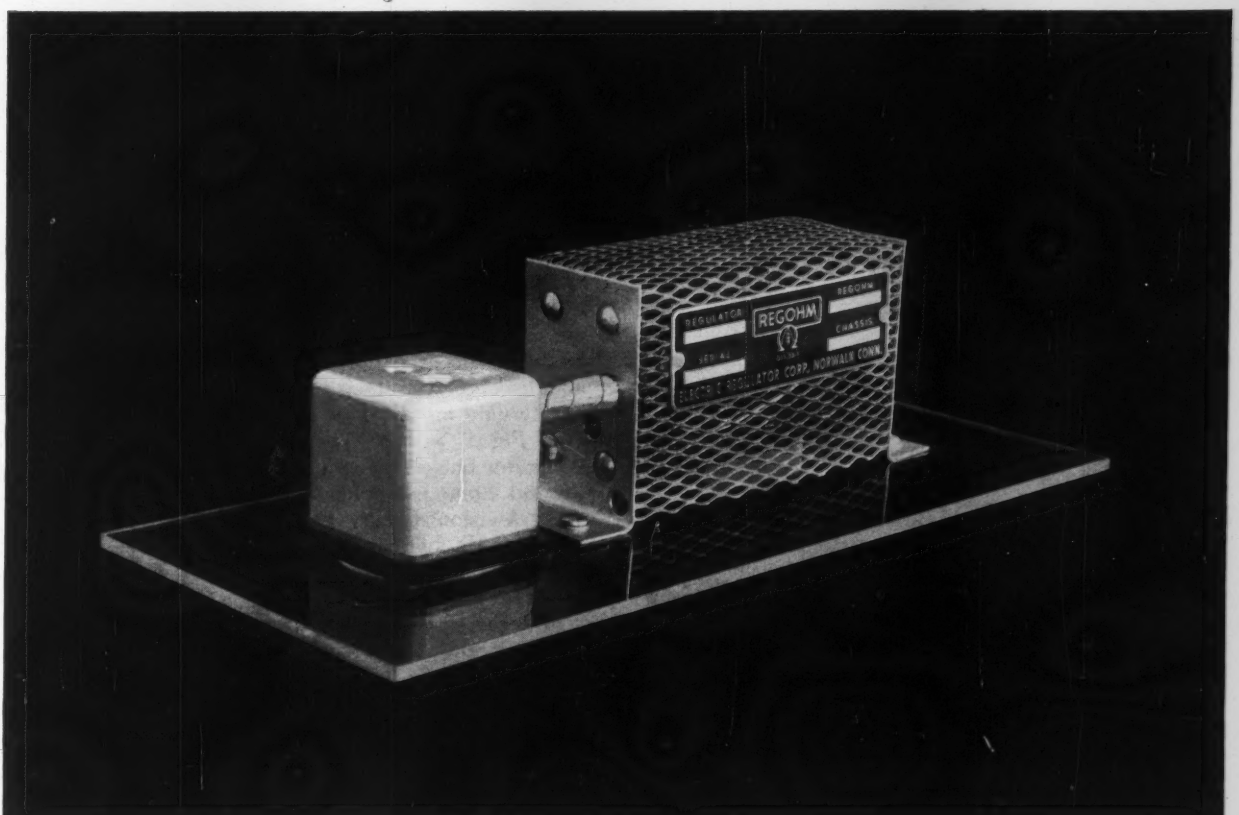
Comparison With a Regulating Transformer

Table 1 shows an actual case-history comparison of a Regohm voltage regulator with a regulating transformer.

Table 1—Comparison With Regulating Transformer

	REGOHM Voltage Regulator	Regulating ransformer
Load Capacity	100 VA	120 VA
Relative Price (50-99 Quantity)	$30.00	$30.00
Output Voltage	100 V (115 V available)	115 V
Input Voltage Range	105-125 V (95-135 V range available)	95-130 Volts
Size	30.5 cu in	168 cu in
Weight	7/8 lb	12¾ lb
Voltage vs Frequency		
a) 54-66 cps variations	½%	8%
b) 45-1000 cps variations	2%	Unsatisfactory
Power Supply* (AC to DC)	±2% (±1% special)	±5%

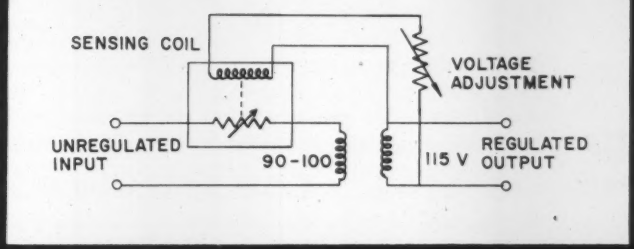
*Add approximately 1.7% additional error per 1% input frequency variation.

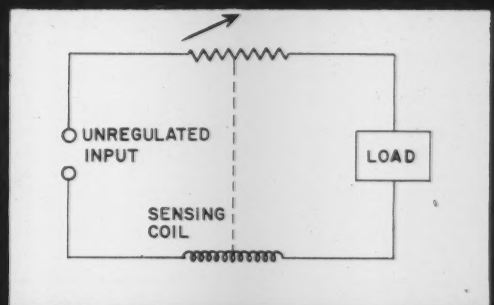


▲ **FIG. 1. REGOHM** (left) is the regulating component and contains sensing coil. Regulating resistors (right) can be mounted remote.

◀ **FIG. 2. PRINCIPLE:** Sensing coil increases or decreases resistance in series with line input to correct for output voltage errors.

▼ **FIG. 3. AS CURRENT** regulator, the sensing coil is in series with the load.





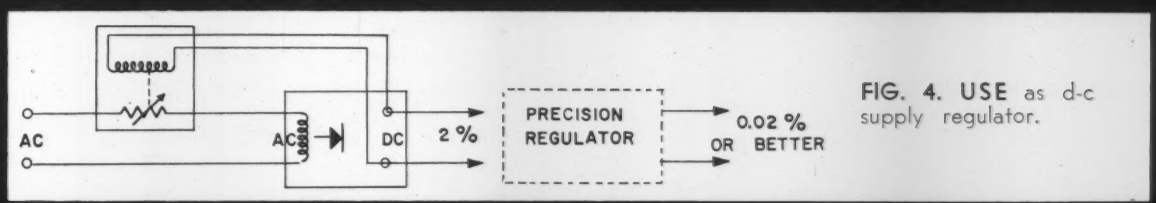


FIG. 4. USE as d-c supply regulator.

ROBERT C. McLOUGHLIN
Topaz Transformer Products, Inc.

ULTRA–ISOLATION TRANSFORMERS

Noise can jump across isolation transformers to disturb high-gain amplifiers and sensitive instruments unless special shielding techniques are used.

ISOLATION TRANSFORMERS isolate one circuit from another while magnetically coupling wanted energy from the one to the other. The familiar ordinary isolation transformer is shown in Fig. 1.

Such a transformer is adequate for use with low-gain circuits or insensitive instruments. However, if the transformer must work into a high-gain load, noise in the primary circuit must be prevented from reaching the secondary because it will be amplified by the high-gain circuit. Special shielding techniques are required to prevent noise in the primary from reaching the secondary via interwinding capacitance and leakage resistance when the transformer load is a high-gain amplifier or a sensitive instrument.

In Fig. 2, primary noise is represented by a noise generator between a long line (e.g., a power line) and ground. Some examples of this type of noise are radio and television signals, ignition static from automobiles and aircraft, switching arc noises, lightning, and electrostatic pickup from the detonation of nuclear devices.

A common technique for keeping such noise from reaching the transformer secondary is to place a grounded single turn of conducting foil between the windings of the transformer (Faraday shield), as in Fig. 3. If insulating materials of high dielectric strength and low leakage are used, a Faraday shield will divert most of the primary noise current to ground. However, enough noise still can be coupled into the secondary because of the electrostatic field around the Faraday shield to cause problems in a high-gain load circuit.

The fringing electrostatic field around the Faraday shield can be reduced by enclosing the complete primary winding in a *box shield* (Fig. 4). By doing this, and shielding the primary leads, the electrostatic field from the primary to the secondary can be reduced to an extremely low value. Effective interwinding capacitance of transformers off the production line can be guaranteed to be less than 0.005 $\mu\mu$f, with leakage resistance guaranteed to exceed 10,000 megohms (usually it exceeds 100,000 megohms). The effective minimum interwinding impedance to noise of typical isolation transformers of this shielded type is given in Table 1.

Even with box shielding, however, some noise current in the primary winding still may affect the secondary via electromagnetic coupling (transformer action). This can be eliminated in one of two ways, as shown in Figs. 5 and 6.

Fig. 5 shows a primary and secondary, each of

TABLE 1—MINIMUM INTERWINDING IMPEDANCE OF BOX-SHIELDED ISOLATION TRANSFORMERS.

Noise Frequency	Minimum Impedance, Megohms
dc	10,000
10 cps	10,000
100 cps	10,000
1 kc	9,600
10 kc	3,000
100 kc	320
1 Mc	32
10 Mc	3.2

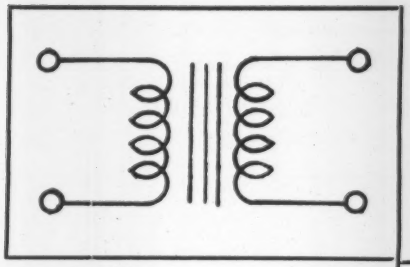


FIG. 1. **TYPICAL** isolation transformer.

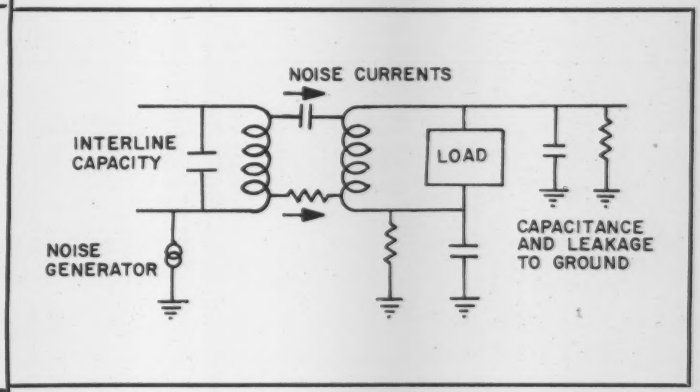


FIG. 2. **NOISE** coupling in isolation transformer.

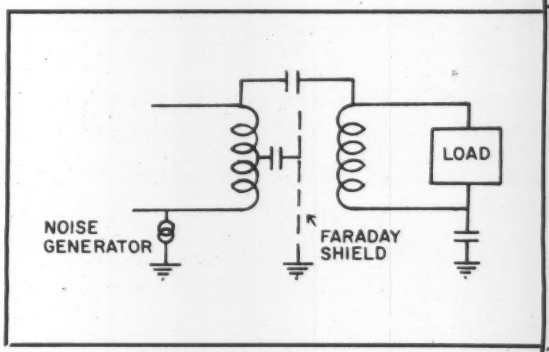


FIG. 3. **GROUNDED FARADAY** shield offers lower-impedance path to ground than that through secondary to ground.

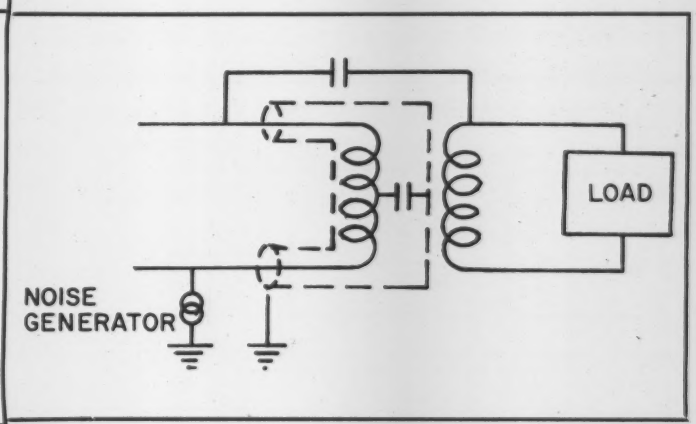


FIG. 4. **COMPLETE** box shielding of primary and its leads reduces inter-winding capacitance to almost zero.

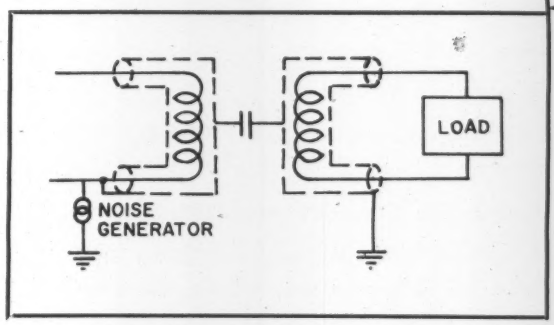


FIG. 5. **TWO SHIELDS** increase capacitance (shield-to-shield) coupling to ground, thus passing more lower-frequency noise components to ground.

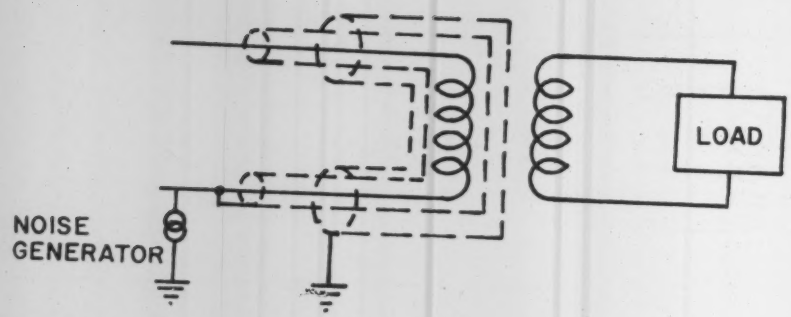


FIG. 6. DOUBLE shielding can be entirely around primary.

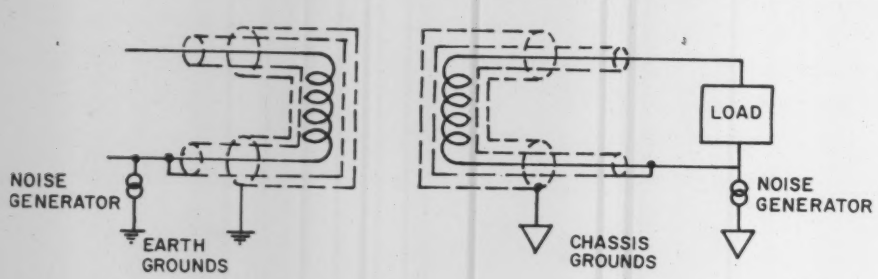


FIG. 7. QUADRUPLE shielding stops noises in both directions.

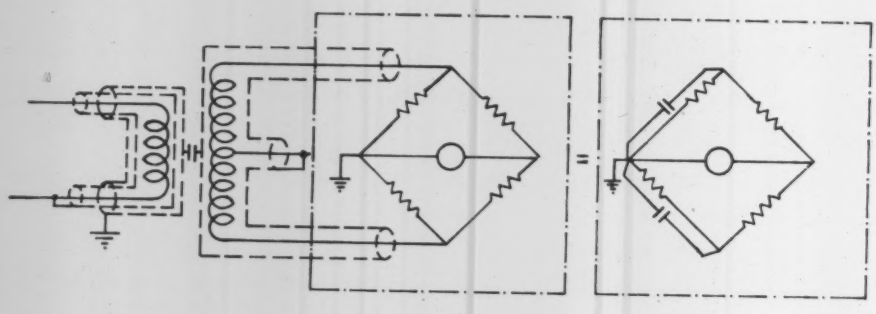


FIG. 8. WHEN transformer feeds bridge, intershield capacitance shunts arms of bridge to ground.

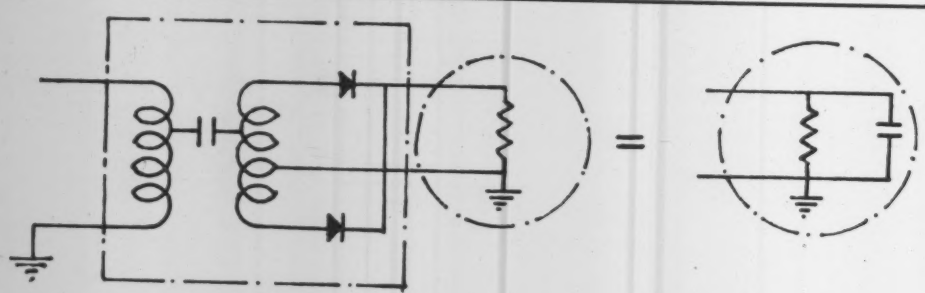


FIG. 9. Interwinding capacitance shunts power-supply load.

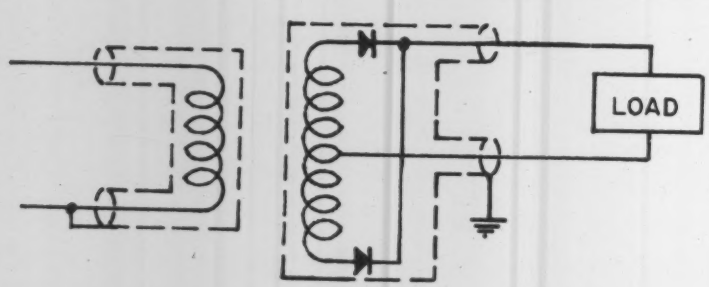


FIG. 10. TECHNIQUE for reducing a-c noise from d-c power supply.

which is completely box shielded. Note that the primary shield is tied to the incoming line on one side, whereas the secondary shield is grounded. Consequently the primary shield assumes the same noise voltage as the primary winding. Therefore, there is no capacitance between the primary winding and its shield. The secondary shield is grounded; there is capacitance between the two shields. Noise currents take this path to ground and do not flow through the primary winding. Hence they do not induce voltages across the secondary.

Also, as the capacitance between the two shields (Fig. 5) is larger than the capacitance between one shield and a winding (Fig. 4), the noise has a better path to ground.

Fig. 6 shows use of two shields, both of which are around the primary. The inner shield is tied to the line and the outer one connected to ground. This circuit is preferable to that of Fig. 5 because of the even higher capacitance between the shields (due to their closeness). The configuration of Fig. 5 is preferable for the transformer in a d-c power supply because a shield on the secondary windings and leads also protects against 60-cps pickup.

Often it is important to shield so that noise currents cannot cross the transformer in either direction. This is done as in Fig. 7.

Use of Transformer With a Bridge

The shielding discussed so far has been concerned with shielding for noise elimination. Special problems appear when the secondary circuit is not grounded, and a high impedance to ground must be maintained. An example is found in the use of a transformer coupled to a bridge circuit (Fig. 8).

The intershield capacitance between the secondary and outer-primary shields appears electrically as being across the two lefthand arms of the bridge, thus shunting the bridge. Unfortunately, high-dielectric-strength materials (which would be used to minimize leakage currents between the shields) would be objectionable because they would increase the intershield capacitance. A compromise is required.

Use of a Transformer with a D-C Power Supply

A similar problem also appears in full-wave-rectified power supplies. Capacitance across the power transformer shows up across the power supply load when the load is grounded, as in Fig. 9.

Practical low values of interwinding or intershield capacitances of this type can be of the order of 25 to 50 $\mu\mu$f.

It was mentioned previously in discussing Fig. 5 that a transformer with shields on both primary and secondary windings and leads was well-suited for d-c power-supply applications. This technique minimizes a-c pick-up for a d-c instrument which is powered by the supply. However, once the secondary leads emerge from their shields, they contribute to the a-c noise in the instrument (prior to rectification). The frequency is generally 60 cps; the a-c voltage is relatively high. By inserting the rectifying diodes within the electrostatic shield surrounding the secondary, as in Fig. 10, the a-c voltage on the emerging leads is the relatively smaller 120-cps ripple.

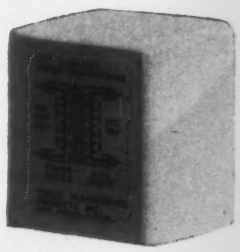


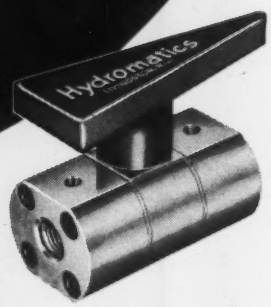
FIG. 11. ULTRA-ISOLATION transformer.

Applications With Instruments

The highly-shielded transformer can be used to keep line-to-ground noise out of common laboratory instruments such as oscilloscopes and voltmeters. Manufacturers of d-c amplifiers and low-noise power supplies, such as those used for strain gages, find them essential. Their use with shielded screen rooms is finding increased favor.

Production-built shielded transformers are available from 5 VA to 30 KVA with maximum interwinding effective capacitances of 0.005 $\mu\mu$f and leakage resistances of 10,000 megohms minimum.

"1,000,000 cycles . . . and still dead tight!"



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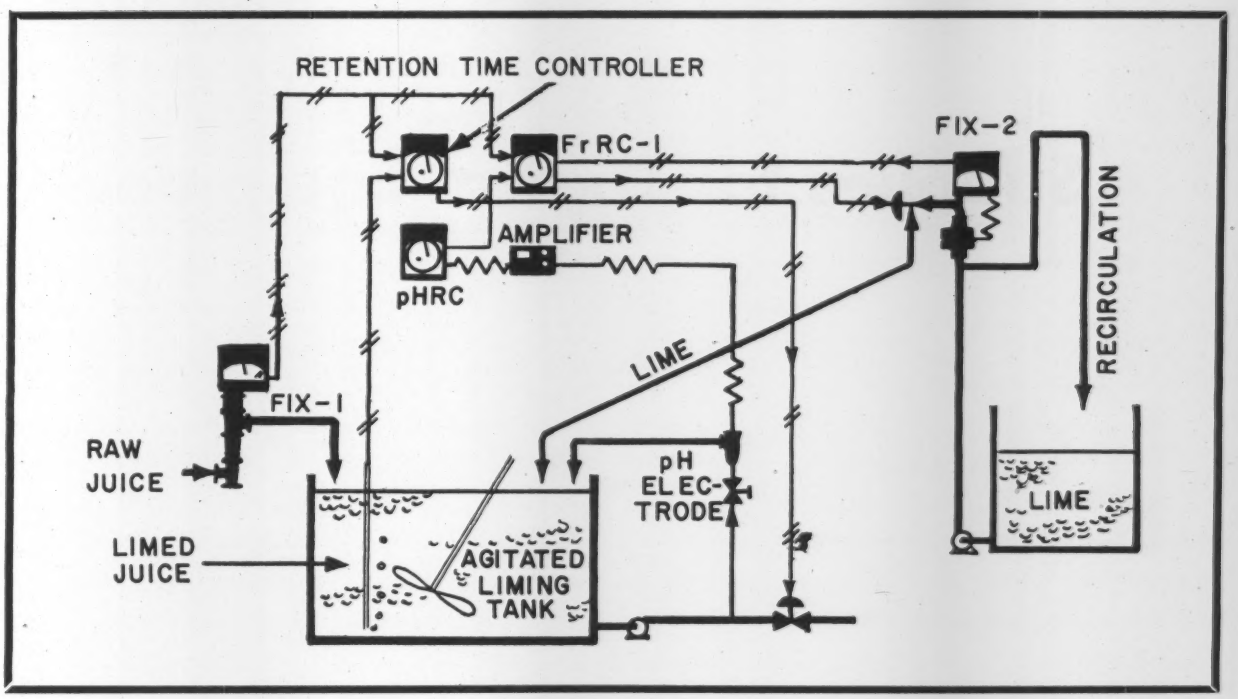
CIRCLE 78 ON READER-SERVICE CARD

AUTOMATIC LIMING OF RAW SUGAR JUICE



One of the most important phases in the production of cane sugar is the liming operation. Milk of lime is added to impart a desired amount of alkalinity.

Two problems must be solved in this operation: (1) Automatic addition of the proper amount of the alkali, and (2) maintenance of a required retention time to insure sufficient interaction between raw juice and alkali. The former is done via control of pH, the latter by adjusting level in a tank in which the mixing occurs.

Basic control action is the ratioing of lime to juice via the pH controller, which adjusts the setpoint of flow ratio controller FrRC. This controls the amount of lime proportional to the amount of raw juice.

This system measures the flowrate of the raw juice to the liming tank by a rotameter-indicator equipped with a transmitter attachment. The pneumatic signal is sent to *two* ratio controllers.

Ratio controller FrRC controls the flow of milk of lime by means of a valve. The flowrate of lime is measured by FIX-2 and transmitted to this ratio controller so that any change in the flow of juice is immediately followed by a proportional change in the flow of lime. The *ratio* between lime and juice is set by pH controller pHRC. The sensing element for pHRC is located in a recirculation line from the discharge back into the tank. Its electrical signal is amplified by an amplifier and sent to the controller.

The second basic problem is to control the mixing or retention time. This is done by raising the level in the mixing tank when flow increases, and vice versa. This is done by the retention time controller, another ratio controller. It receives both a signal proportional to the liming tank *level* (via a bubbler) and also a signal proportional to raw juice flow. It maintains the tank level at a desired *ratio* to the juice inlet flow by throttling a valve in the discharge of the liming tank. Thus the *retention time* for the juice in the liming tank is maintained at a desired value.

Equipment required: FIX-1: armored flowmeter of all-stainless-steel construction with Magnabond pneumatic transmitter (Model 10A1152-1401KA41); two recording ratio controllers (Model 1102WR16-WR02 with Model 53PP4512 ratio controller having proportional-plus-reset control modes); FIX-2: magnetic flowmeter Model 10D1416; indicating pneumatic transmitter Model 1323BF41; potentiometer recorder controller for pH (Model 1102BP11 with Model 53PR4512 pneumatic controller), amplifier and electrodes; two control valves; Model 13P3135 bubbler-type level system; accessories.

Source: Fischer & Porter Co., Warminster, Pa.

STEWART T. COFFIN
Dynamic Controls Co.

Supplies for Digital Equipment

Here are some of the special considerations in the design of power supplies for digital equipment—allowable variation, type of regulator, dynamic regulation required. Also discussed are various techniques for overriding line transients.

DIGITAL SYSTEMS usually are synthesized from large numbers of modular circuits designed around a predetermined set of standard power voltages, thus realizing the advantages of a centralized power supply. The allowable power-supply voltage variation usually is kept less than that which the individual computer circuits can tolerate by a factor of 10 to 100. This design margin is made large to allow for component deterioration in the switching circuits and for other forms of system degradation.

Type of Regulator

Power supplies commonly used with modern digital equipment may be classified, according to the regulation principle used, into one of the following types, listed in order of improving regulation, increasing complexity and cost, and decreasing reliability:

open loop	Unregulated
open loop	Resonant (constant voltage transformer)
closed loop	Synchronous (magnetic amplifier, controlled rectifier)
closed loop	Wide-band (series or shunt transistor)

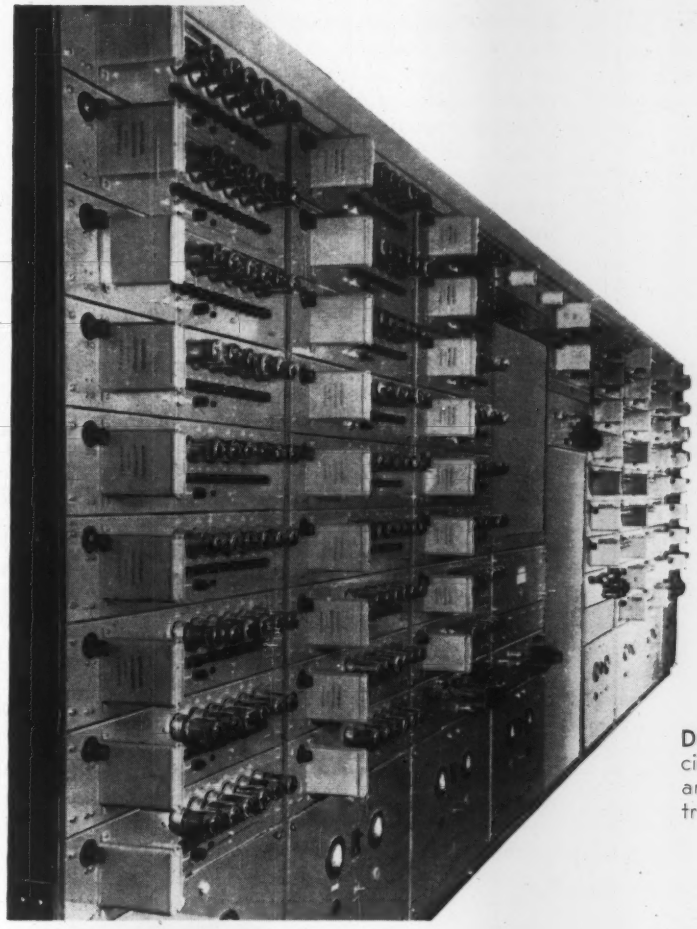
The use of a regulator type having closer than necessary regulation can actually decrease, rather than increase, system reliability because of its greater complexity. The wide-band regulator particularly is often found to be impractical for use in large systems, especially when efficiency and cooling are a major consideration. Choice of one of the other types depends mainly on the dynamic characteristics of the load current and line voltage. Power supplies using combinations of regulating schemes often are the most satisfactory.

Conditions Under Which the Regulation is to be Maintained

Specifying the allowable voltage variation has little meaning unless the conditions under which the regulation is to be maintained are prescribed accurately.

For example, the terms "0.01% regulation" or "precision regulated" have little meaning in themselves, and usually refer only to the steady-state regulation. The dynamic load and line responses are more important.

The dynamic nature of the load is often difficult to predict, and must be estimated or determinated experimentally. In typical systems, load steps greater than 5% are unusual during normal operation. In cases of severe load *steps*, it may be worth-



DIGITAL EQUIPMENTS have special power-supply requirements, and must be guarded against line transients.

while to modify the switching circuits to draw a more nearly constant load because step changes are the most difficult type of disturbance to regulate against.

A common error is averaging the load variation over too short an interval of time (or not averaging it at all). Because of the decoupling capacitance which is required within the digital equipment, only load disturbances below a certain frequency (usually around 10 Kc) appear at the power supplies. An instantaneous step of load current flowing through the finite output inductance of any power supply is theoretically impossible. Thus an upper frequency limit is implied whenever regulation to steps of load is specified.

Line transients are a common cause of computer malfunction. Small line fluctuations are attenuated using conventional regulation and filtering techniques.

Accidental Overvoltage

There are four common causes of accidental overvoltage of the d-c power supplies:

1. Overshoot upon turn-on, or upon recovery from heavy load or line transients.
2. RF inductive switching transients, either in the a-c line or generated within the power supply.
3. Steady overvoltage resulting from failure of the power supply regulator.
4. Short circuits between two voltages of the same polarity.

The simplest solution to overcome the problem of overvoltage is to avoid use of power-regulating devices which are prone to accidental overvoltage. These usually include devices having closed-loop regulators. An alternate approach is to design the switching circuits to tolerate the maximum possible overvoltage. This includes adequate voltage rating of capacitors and semiconductor junctions, and adequate wattage rating of power dissipating components.

If two different power voltages of the same polarity are used, and they become accidentally shorted together, there is instantaneously a voltage division between the two, depending on the relative charges stored in each, followed by the lower voltage increasing toward the higher voltage. Avoid the use of two voltages of the same polarity if at all possible.

When several voltages are used, the effect of their mutual variation is frequently more important than their absolute variation with respect to ground. A good example is the inverter with clamped collector load so commonly used, requir-

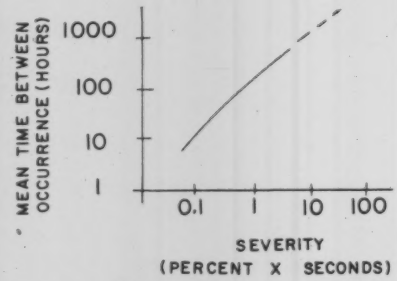


FIG. 1. SEVERITY of transient (duration X % decrease) versus time between occurrence. Curve can be extrapolated to estimate the rate of occurrence of severe outages.

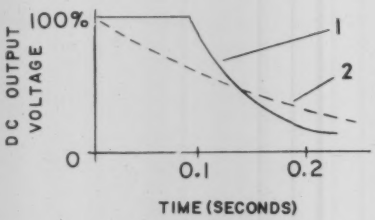


FIG. 2. POWER-SUPPLY decay for decrease in line voltage for (1) power-transistor type supply and (2) magnetic-amplifier type supply. The large filter capacitance used in the latter results in a longer time-constant.

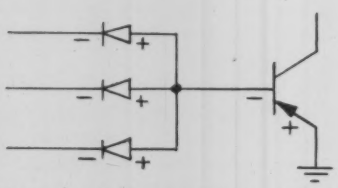


FIG. 3. DIODE "OR" circuit. This circuit is common in digital circuitry and equipment; low-level failure limits are of importance.

ing two different voltages of the same polarity. In a typical design, variation of either voltage alone by ±10% may be the equivalent of simultaneous proportional variation of ±50%, or simultaneous opposite variation of ±5%. This effect, which applies to all digital circuits, is important when determining allowable voltage variation. In some cases it is worthwhile to control the regulator of the smaller, more closely regulated supply by the output of the larger supply; in other cases it may be best to return the output of a supply to a voltage other than ground.

Overriding Severe Line Disturbances

Digital computers in real-time control applications demand error-free operation over long periods of time. If a computer is energized by public-utility a-c power, fluctuations on the a-c line (because of switching transients, faults in the utility system, lightning strikes, or application of heavy loads) can cause computer malfunction. Three aspects of the problem are (1) the quality of the a-c power source, (2) the characteristics of the power conversion equipment, and (3) the tolerance of the digital equipment.

Quality of A-C Power Source

The reliability of the a-c power source can be determined by use of instruments to record duration and magnitude of line-voltage fluctuations over an extended period of time at the location in question. It is usually found that transient *increases* of voltage are negligible. If the product of duration and percentage decrease is used as a measure of the severity of the transients, then severity is roughly proportional to mean time between occurrences. This statistical relation can be represented graphically and extrapolated to a certain extent for estimating rates of occurrence of more severe outages (Fig. 1).

If it is found that the transient severity is unusually high, then the situation usually can be improved by more direct service (a separate building circuit or a separate substation from a high line). This is mainly a question of economics.

One form of power transient frequently overlooked is the high-frequency transient generated in nearby equipment when switching an inductive load such as a transformer primary winding. Because of the stray inductance and capacitance present in such devices, a high-frequency ringing occurs, typically at one to ten megacycles frequency. This energy is transmitted through the power line to the computer supplies, and through the power supplies by the stray capacitance of the power transformers and chokes. It is not absorbed by the electrolytic capacitors because of their high impedance at these frequencies. This can cause computer malfunction, and can even destroy semiconductor components.

The cure for high-frequency type trouble is filtering of the a-c line. Generally, oil-type capacitors across the a-c line and from the a-c line to ground provide adequate filtering. The proper size

required can be determined experimentally, and is typically 1 to 100 μfd.

Power-Conversion Equipment

Magnetic-Amplifier and Transistor Supplies

The most common forms of power conversion consist simply of regulated d-c power supplies employing either magnetic amplifiers or power transistors. With either type the regulator can tolerate a certain decrease in line voltage before saturating, the exact amount varying greatly with the design. A regulator can be designed to tolerate almost any decrease in line voltage down to a few percent of rated voltage, the only consideration being economics.

Regulation at 50% rated line voltage is achieved easily. For rapid decreases of line voltage within the operating range of the regulator, the output voltage of a properly designed power-transistor-type regulator remains essentially constant. For a magnetic-amplifier-type regulator, however, the transient appears in the d-c output attenuated to a greater or lesser extent, depending on the design. With proper design, attenuation by a factor of 10 is practical.

For sudden decreases of line voltage to well below the range of the regulator, the two types of regulators behave differently. The output of the power-transistor regulator remains constant for a certain period of time (depending on the load and the excess charge stored in the filter capacitor) and then decays exponentially. The output of the magnetic-amplifier regulator, however, starts decaying immediately, usually with a much longer time-constant because of the larger filter capacitance (Fig. 2). In general, the characteristics of the power-transistor-type regulator are somewhat more suited for over-riding transients, but the magnetic-amplifier-type regulator can do nearly as well, and may be selected for other reasons not related to the problem under consideration.*

Motor-Generator Sets For Over-riding Outages

For over-riding outages greater than a few cycles, the capacitance required in a conventional power supply becomes excessive, and the energy must be supplied by other means. The most common solution is a buffer M-G set, sometimes equipped with a flywheel. With a suitably designed regulator, the average M-G set can supply rated output for approximately 0.3 second with no input.

Chemical Storage

If much larger outages are to be over-ridden, then chemical storage usually is used.

Power supplies have been designed in which the filter capacitance of a conventional regulated supply is replaced by a storage battery, which supplies the load current whenever the line voltage drops too low. A limitation of this scheme is the amount of energy that can be stored economically in batteries, depending on the load requirements and the duration of the outage. Other factors which must be considered are the difference between charging and discharging potential of the battery (which may be as high as 15%), the necessity of d-c contactors for each supply, the non-adjustability of the d-c voltage, and the necessity of using d-c voltages which are some multiple of the cell voltage.

Another scheme which has been used consists of a battery-powered inverter that automatically comes on the line when necessary. An advantage of this is that it can be retrofitted easily into an existing system.

Tolerance of Digital Equipment

With any power-conversion scheme, the difficulty of over-riding line transients varies directly with the power consumed by the load. Therefore, it is essential that power consumption by the computer be minimized. Computer elements such as gates and flip-flops can be designed to operate reliably at power levels of only a few milliwatts if necessary, but the circuit designer will often use far more power than this. Clamped current sources and stiff voltage dividers are the largest power users. Use of switching transistors with low leakage, and reduction of cable lengths through miniaturization permit reliable operation at lower power levels.

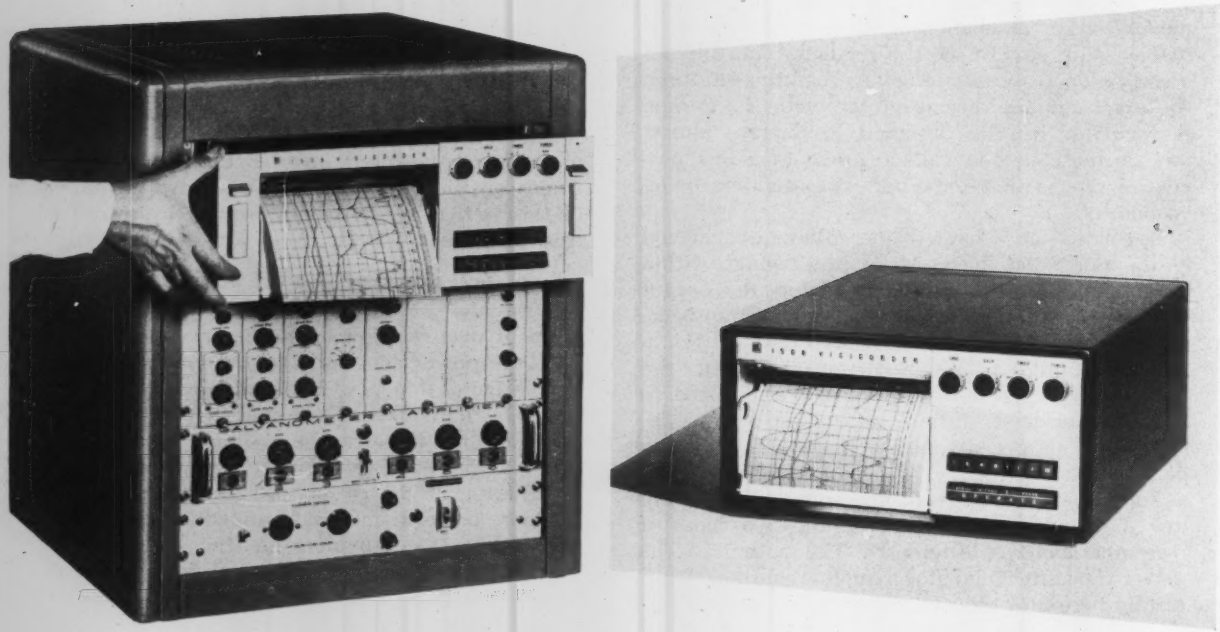
Careful design can result in great savings of power. It is usually worthwhile to keep the nonessential loads, such as indicator lamps and other display devices, on a separate power system, so that it is not necessary to supply power to them during line transients.

A further refinement which is possible is to automatically stop the computation for the duration of the transient. Then it is necessary to maintain continuity of power only to memory circuits.

The most important factor affecting the computer's line-transient susceptibility is the tolerance of the switching circuits to d-c power voltage variation. Transistor switching circuits can be designed to tolerate rather large variations of d-c power voltage.

The use of nonlinear components complicates the design of circuits. Accumulative diode forward voltage drops should be guarded against. In Fig. 3, the forward voltage drops of the diode OR circuit and emitter-base junction are additive, and the circuit is therefore more susceptible to failure at low voltage levels than the transistor NOR circuit. Magnetic components, such as ferrite-core pulse transformers are inherently nonlinear, and require extremely careful design if they must be used at all. Certain devices, such as core memories, depend on a nonlinear characteristic for their operation, and therefore cannot possibly tolerate wide voltage variation. On the other hand, other memory devices such as drums, tapes, and delay lines are linear in their operation.

*Characteristics given for the power-transistor-type regulator apply also to other wideband-type regulators such as power zener diode or series tube types. Characteristics given for the magnetic-amplifier-type regulator apply also to other synchronous-type regulators such as controlled rectifier or thyratron types.



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Reluctive transducers convert the variable to be measured (pressure, acceleration, position, force, torque) into an a-c voltage by changing the reluctance in a magnetic circuit. This reluctance change varies the amplitude and/or phase of either a self-generated or external voltage.

RELUCTIVE TRANSDUCERS are similar in principle to inductive transducers which use the variable to be measured to alter the self-inductance of a single coil. This inductance usually is changed by motion of a core within, or in close proximity to, the coil.

Available full-scale measuring ranges of reluctive transducers vary from ±0.1 to ±700 g for *accelerometers*, 0.01 to 200 inches for *rectilinear position transducers*, 3 to 360 degrees for angular position transducers, and 0.1 to 5000 psi (absolute, gage, differential) for *pressure transducers*. It should be noted, however, that the range selected can have a large effect on performance characteristics.

In addition to the measurands described above, reluctive transducers are used also for *force* and *torque* measurements. The reluctive transducer principle also is used in *proximity* and *velocity* transducers, and in frequency-output *flowmeters* and *tachometers* in which a toothed rotor or vane assembly varies the reluctance path under a single coil by the successive passing of the magnetic tooth or vane tips.

The most-frequent applications of reluctance pressure, position, and acceleration transducers are found in a-c control systems, in a-c measuring systems and, with d-c to d-c converters, in d-c measuring systems where special requirements exist. These requirements include primarily: (1) Need for frequency response higher than obtainable with a potentiometric transducer, but not high enough to necessitate the use of a strain-gage transducer, which may offer certain disadvantages for a particular application; (2) expanded-range measurements with suppressed zero; (3) measurements of small absolute or gage pressures; (4) measurement of differential pressures in the presence of high, and widely fluctuating, reference (line) pressures; (5) measurements of very small or very large rectilinear position changes; (6) need for very small resolution in the (0-5 v) transducer output where such "infinite" resolution can be of benefit in conjunction with the associated data transmission and read-out systems.

Inductive transducers still are used in L-C tank-circuit-type subcarrier oscillators, where they form the frequency-controlling inductance (with a fixed capacitor installed in the oscillator unit). However their use has diminished during the last few years because of difficulties in compensating them for temperature effects. Temperature compensation of inductive transducers relies on careful balance of core and winding materials as to temperature-vs-permeability characteristics.

Reluctive transducers use the ratio of two coils and, therefore, are less subject to temperature effects than one-coil devices. They require a relatively small motion of their force-summing member to yield a usable a-c output voltage. Their simple construction lends itself to operation while in contact with a large variety of fluids including corrosive media. These features have established a place for reluctive transducers in instrumentation systems. Their primary use is for measurements of *pressure* (absolute, gage, and differential), *displacement* (or position), and *acceleration*.

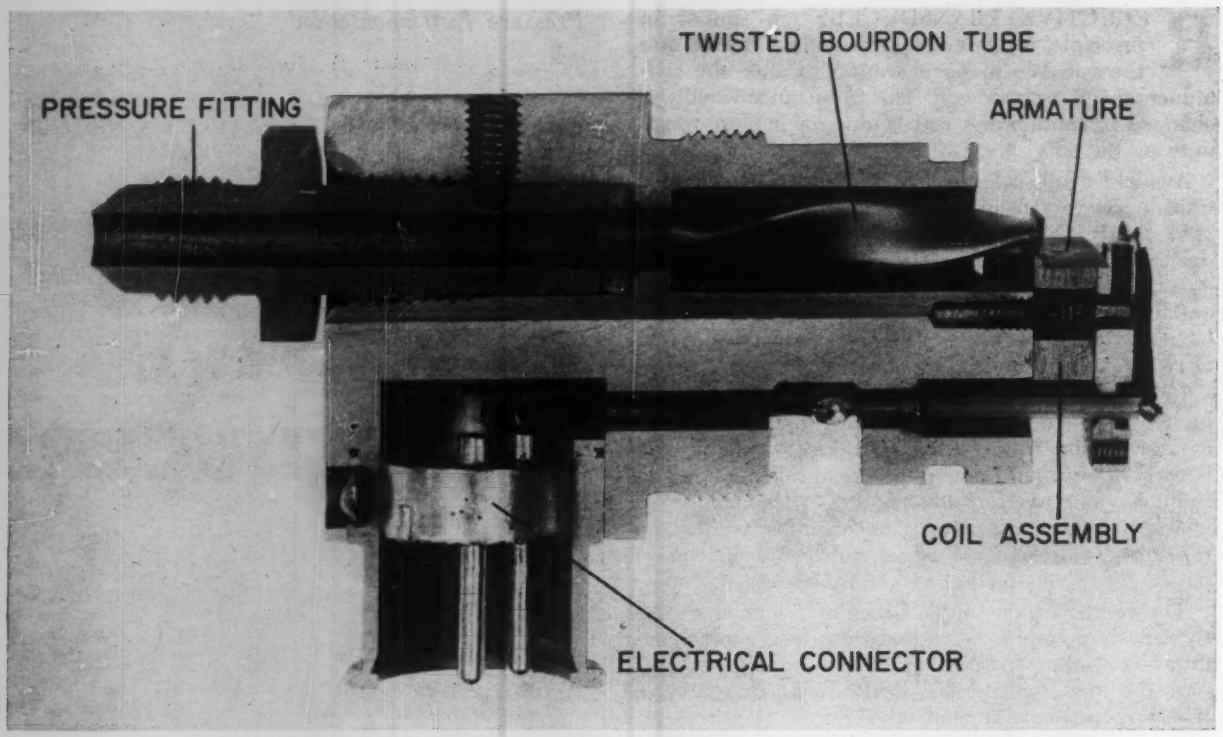


FIG. 1. PRESSURE TRANSDUCER uses twisted Bourdon tube as sensing element. (Photo courtesy Daystrom-Wiancko)

Sensing Elements

Sensing elements in common use are diaphragms and twisted Bourdon tubes for pressure measurement, movable cores for displacement measurement, and torsional springs with weighted armatures for acceleration measurements.

Bourdon tubes (Fig. 1) are used to move a magnetic armature connected at their tips.

Diaphragms (Fig. 2) can be made from magnetically-permeable material, or equipped with integrally mounted magnets or electromagnets. They are supported around their edge by clamping, brazing, or welding to a short "inner case" of tubular cross-section. This sensing portion also can be made by machining the inner case and integral diaphragm from bar stock.

Movable cores, used in position transducers, are made from magnetically permeable material so that they vary the reluctance of the unit.

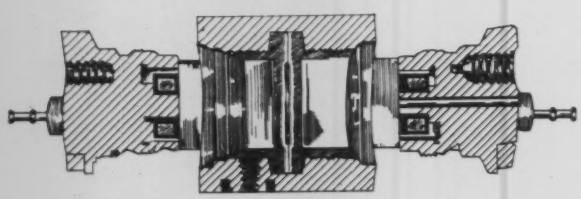


FIG. 2. SECTION through pressure transducer shows integrally machined diaphragm in center, coil on core in each of the threaded end pieces, terminals for electrical connections. (Courtesy Tavis Eng. Div. of Edcliff)

The *weighted-armature/torsional-spring element* is used in acceleration transducers*.

The sensing element is the only moving part of a reluctive transducer. Very small motions can be used to vary the reluctance path between the coils or windings sufficiently to obtain full-scale rated output from the transducer. Diaphragm motion is typically measured in thousandths of an inch. The opposite effect is desired in rectilinear motion transducers, where core travel can be 10 feet or more for continuously-varying output readings up to full scale.

The coils in reluctive transducers usually are wound on "E"-shaped cores. One or two "E"-core coils can be employed. Coil assemblies can be potted or coated to withstand many types of fluids, even some corrosive liquids and gases. Use of ferroceramic core materials permits reduction of coil size and improves some performance characteristics.

Differential-Pressure Measurement

Diaphragm-equipped *differential-pressure transducers* can be made to perform without appreciable error over wide ranges of reference pressure when the ratio of reference pressure to full-scale differential pressure is 100:1 or greater. This remarkable feature, presently not matched by other transducer types, is obtained by applying the pressure to (1) one side of the diaphragm from the reference port and (2) also to a cavity surrounding the tubular inner case. This prevents error-causing deformation of the inner case

*See *I&CS* April, 1959, page 540-549, for survey of acceleration transducers.

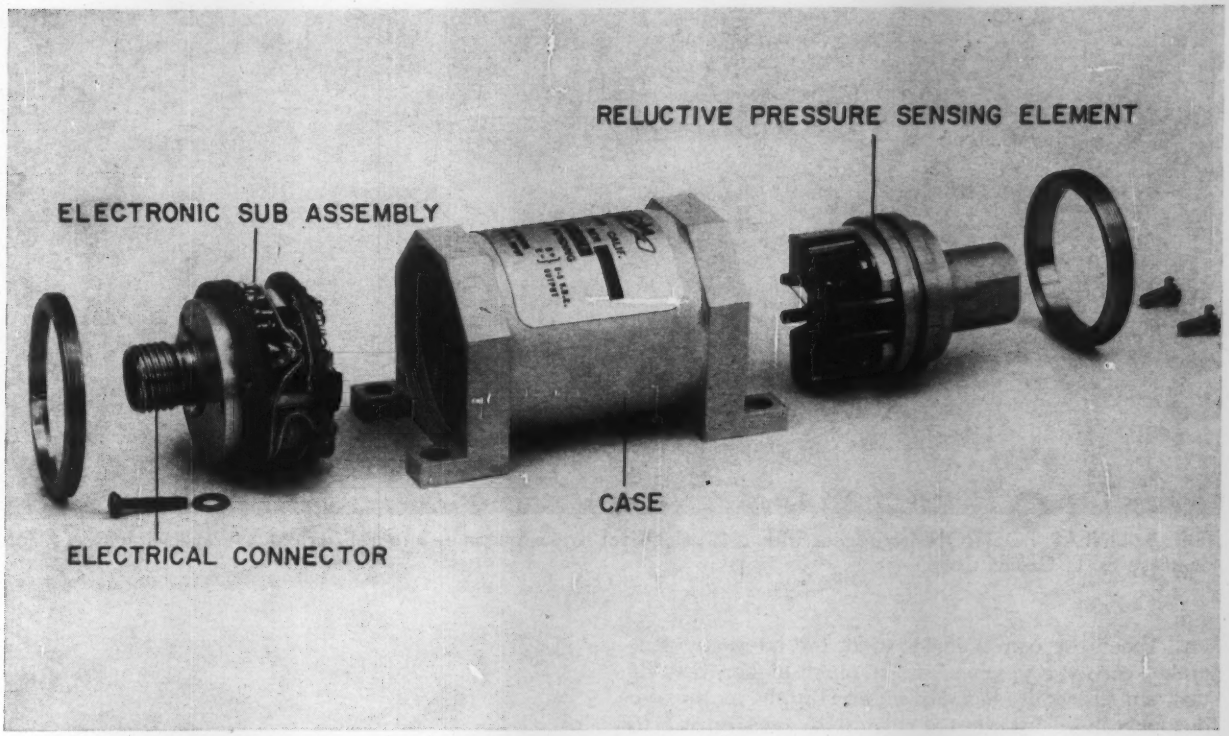


FIG. 3. PRESSURE transducer with integral d-c to d-c converter has separate sensing and electronics modules. (Photo courtesy Daystrom-Wiancko)

to which the diaphragm is attached. Differential-pressure applications include the measurement of flow through a venturi or orifice in a high-pressure line, and of small pressure-differentials between two high-pressure lines.

Scale Expansion

Another useful design variation permits pressure measurements with scale expansion near the upper-range end point. This feature is obtained from a twisted Bourdon tube designed so that no appreciable motion occurs until the lower end point of the expanded range is reached. The expanded range can be as small as 10% of the upper-range end pressure (e.g., 450-500 psi for zero to full-scale output.)

Conversion Circuitry

In order to cope with the increasing use of d-c measuring systems, most manufacturers of reluctive transducers have developed d-c to a-c to d-c conversion circuitry for separate or integral packaging with the transducer. Reluctive transducers with d-c excitation (usually 28 v) and 0-5 v d-c output are now available for absolute, gage, and differential pressure (Fig. 3) as well as position and acceleration measurements.

In a typical design, the d-c excitation voltage first is regulated to a lower value so that relative freedom from line variations is obtained. The d-c then is "chopped" into a-c, the a-c voltage is applied to the primary winding, and the a-c output voltage then is demodulated and filtered so that a relatively ripple-free d-c output voltage is obtained. An output limiter can be added to prevent excessive output levels should overload occur.

Some designs incorporate feedback-controlled amplification for the a-c output voltage prior to demodulation or rectification. The addition of an amplifier permits smaller sensing-element motion and, therefore, stiffer sensing elements. This feature appears to be useful when low pressure ranges (0-2 psi or less) must be measured in the presence of high vibration.

D-c conversion circuitry usually uses solid-state components. These, and all associated components, must be sufficiently underrated and properly packaged and sealed to provide necessary operational reliability. Some existing designs still lack this high level of reliability; however, manufacturers are engaged in constant research and development to resolve existing discrepancies in d-c output reluctive transducers.

Performance

Performance characteristics of reluctive transducers, with or without d-c to d-c converters, are comparable in most respects to those of the best available versions of other transducer types. *Static-error bands*, referred to a straight line between theoretical end points, are on the order of $\pm 1\%$, with nonlinearity occupying the major portion of the error band. Errors due to *hysteresis* and *nonrepeatability* can be kept below 0.5%. Proof pressure ratings of greater than six times rated range can be supplied.

Basic a-c transducers presently are designed to operate at a carrier frequency in the range of 60 to 5000

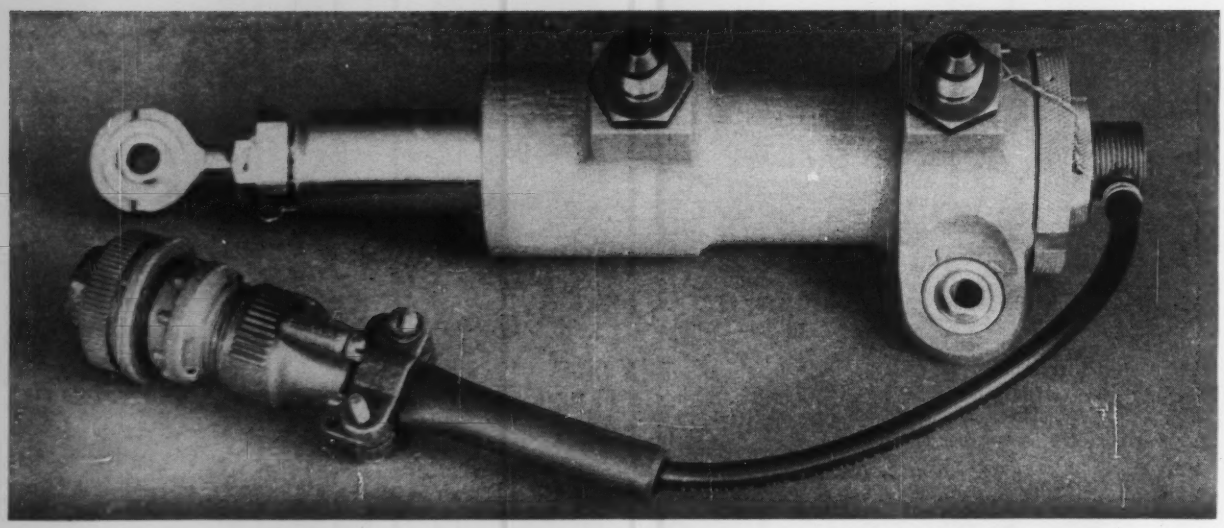


FIG. 4. LINEAR POSITION transducer with ±2" electrical stroke becomes integral part of hydraulic actuator. (Photo courtesy G. L. Collins Corp.)

cps. When d-c conversion is used, the internally-generated carrier frequency can be much higher, permitting smaller coils and capacitors. Ripple in the d-c output, caused by internal carrier frequencies of 1 to 100 kc, can be kept below 0.5%. Source impedances range from 200 to 10,000 ohms.

Temperature effects can be minimized by proper selection of sensing element and coil materials; temperature errors are typically 1.5 to 2% per 100°F. Reluctive transducers without d-c conversion can operate over a wide range of environmental temperature with existing upper limits of 350°F (pressure transducers) to 1200°F (position transducers). The solid-state components of d-c converters limit normal operating temperatures of transducer so equipped to −65 to +200°F.

Acceleration and *vibration errors* vary from 0.001 to 0.1% of full scale per g for most measured ranges. These errors can become large in low-range transducers unless internal amplification is used in conjunction with stiff sensing elements.

The *frequency response* (flat within ±0.5 db) of reluctive transducers lies in the medium region (50 to 1000 cps) and depends on design and application. The highest response frequency is obtainable from high-range, small, diaphragm-equipped transducers, without d-c conversion, which can be installed directly into a boss on a duct or vessel without connecting tubing.

D-c to d-c pressure transducers, and transducers using sensing elements other than diaphragms, contain a larger internal volume, which lowers the frequency range. Since pressure transducers with d-c converters usually are sufficiently heavy to necessitate remote installation with connecting tubing, the useable frequency range is limited by this tubing rather than the internal volume and natural frequency of the transducer.

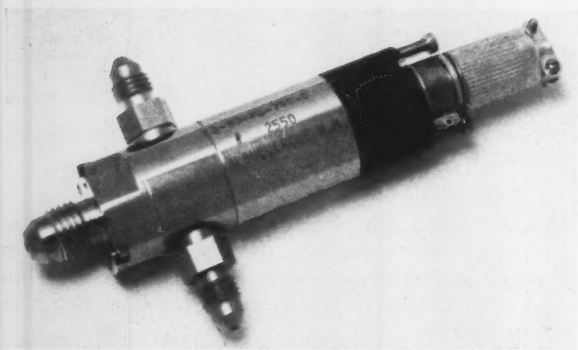


FIG. 5. CONSOLIDATED CONTROLS Model S-80 Ultradyne pressure transducer uses variable-reluctance principle.

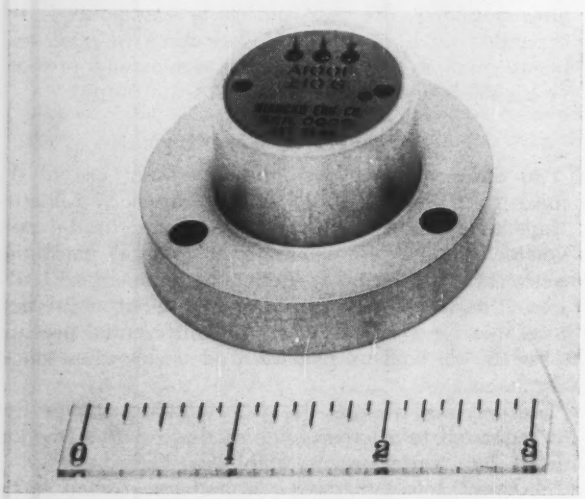


FIG. 6. ACCELERATION transducer is available in ranges from ±0.5 g to ±1000 g, requires 20-v, 3-kc excitation. (Photo courtesy Daystrom-Wiancko)

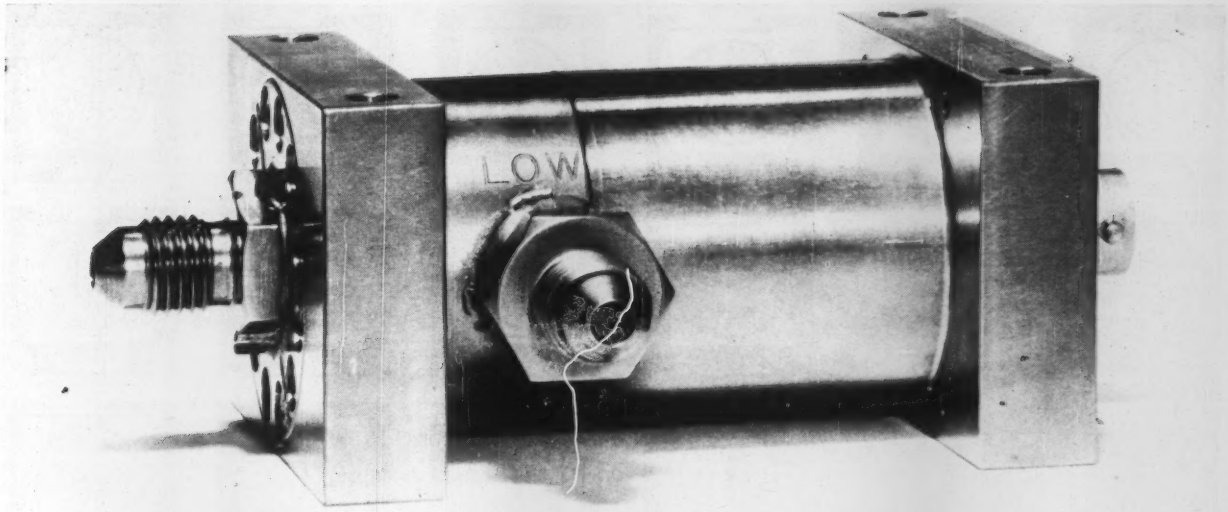


FIG. 7. ASTROMICS A40-1 pressure transducer uses variable-reluctance principle.

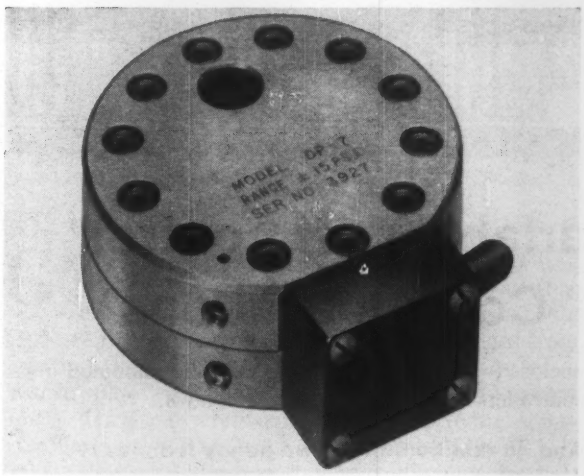


FIG. 8. BORG-WARNER Model DP-7 variable-reluctance differential-pressure transducer.

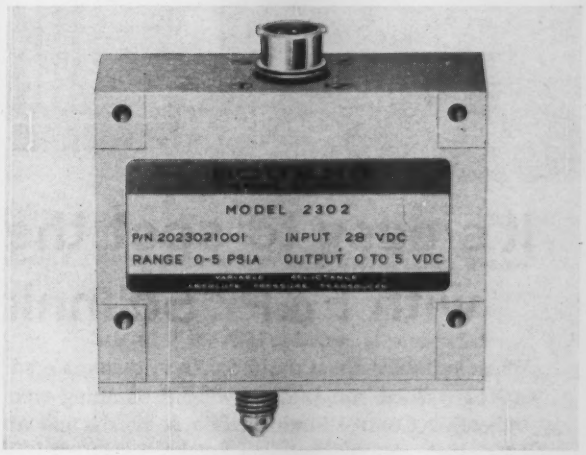


FIG. 10. BOURNS Model 2302 provides d-c output from unregulated 28 v d-c input.

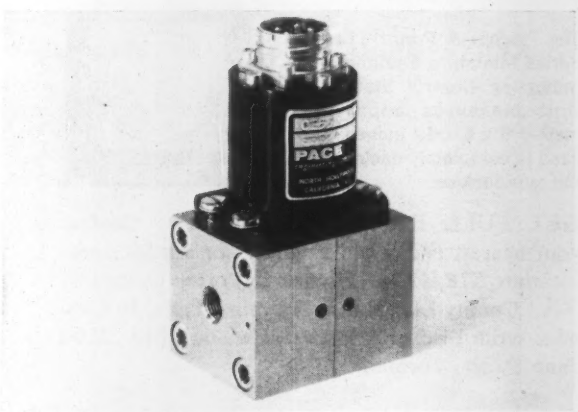


FIG. 9. PACE Model CP53D industrial-type features simple disassembly for range change, transistorized carrier-demodulator.

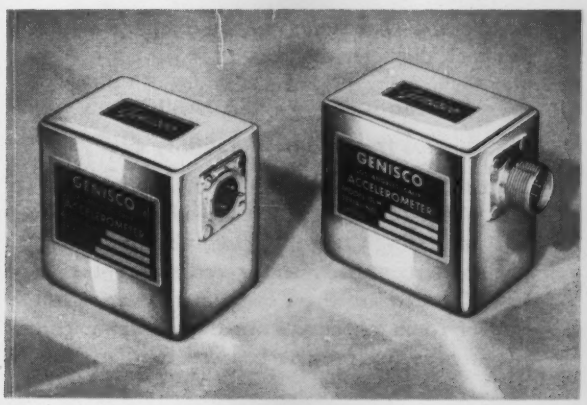
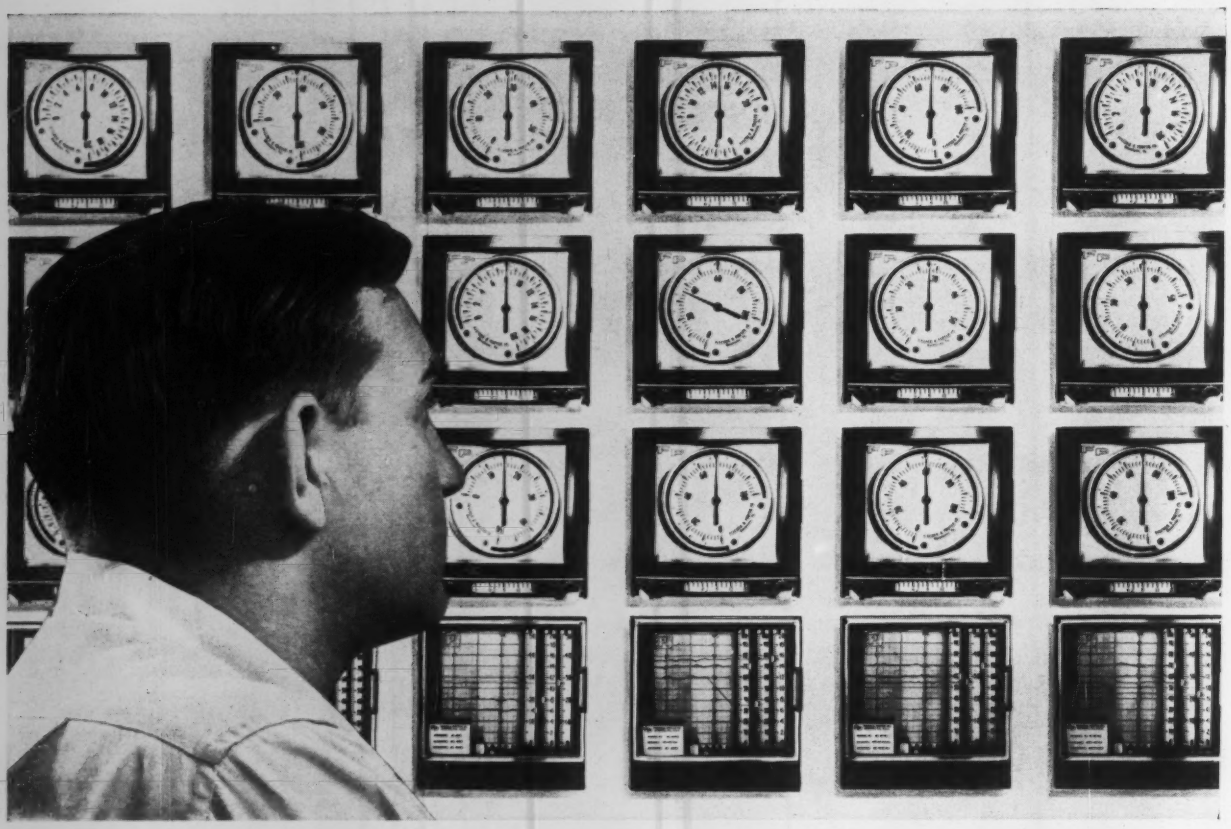


FIG. 11. GENISCO Models DDL and DDS use variable reluctance principle and same housings as shown above.



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Control Logic, Inc.

BINARY-TO-GRAY CODE CONVERSION

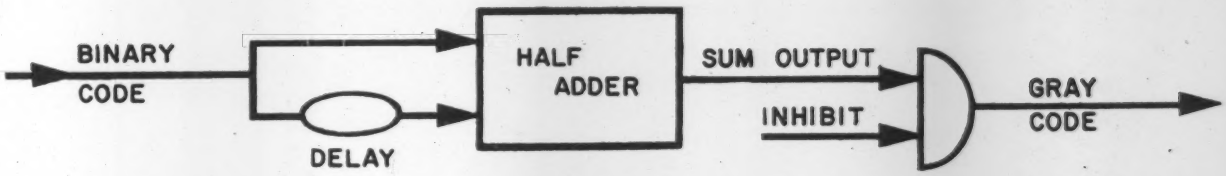


FIG. 1. BINARY-TO-GRAY conversion circuit.

Binary code can be converted to Gray (cyclic) code by a half-adder plus a few auxiliary components.

GRAY* (or cyclic) code is a method of counting in the binary number system in such a way that only one binary bit changes at a time (Table 1). Note that in Gray code only one bit changes from count to count. This precludes the possibility of a "catastrophic" mistake such as is possible in straight binary when many bits can change even if the difference between two readings is one unit, such as 01111-10000. Hence, in the event of an ambiguous reading (such as being half way between two numbers in a progression) the error in reading can occur only in one column. This is important in measurement applications, as in shaft-angle encoders.

TABLE I—DECIMAL, BINARY AND GRAY CODES

DECIMAL	BINARY	GRAY CODE
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

This article describes a simple circuit to convert a number from binary to Gray code. One application for such a circuit is in a test unit to simulate a shaft encoder's output.

Serial Binary-To-Gray Conversion

An interesting relation exists between a binary-coded number and the same number expressed in cyclic code. **If the binary number is shifted one place to the right (delayed) and added to itself, without carry, the result is the cyclic-coded number—when the least-significant bit (LSB) is discarded.**

For example, consider the decimal number 11, whose binary-number equivalent is 1011, and whose cyclic equivalent is 1110.

To obtain the cyclic equivalent of 1011, add the following without carrying:

$$\begin{array}{r} 1011 \\ 1011 \\ \hline 11101 \end{array}$$

After discarding the least-significant bit, the answer is 1110, the cycle equivalent of decimal number 11.

Implementation

This process (delay and add without carry), can be implemented by the circuit shown in Fig. 1. The delay circuit is the equivalent of a shift right of one place, and the sum output of the half adder provides the desired sum without a carry.

Note that the MOST-SIGNIFICANT BIT (MSB) must be presented first (time t_1) to the half adder. This is shown at the top in Table 2.

*Named after Dr. Frank Gray, inventor of the code.

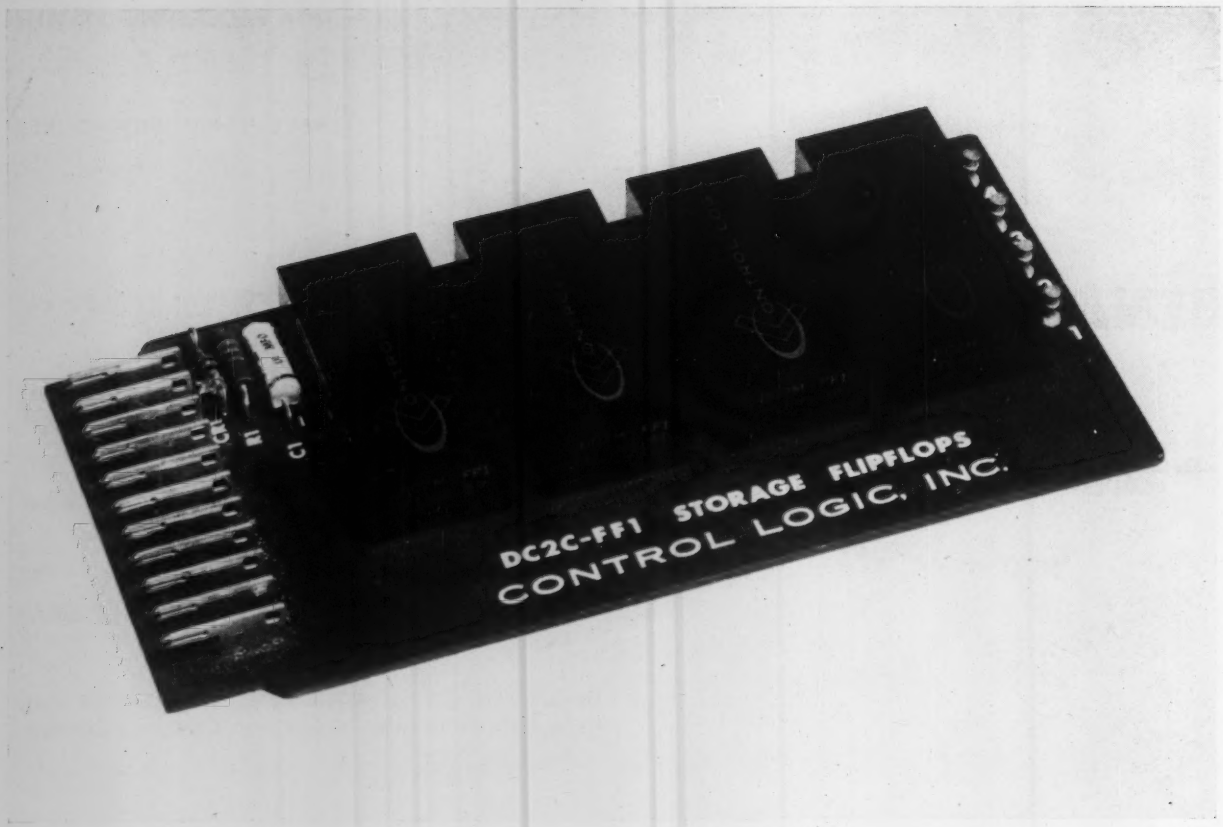


TABLE 2—TIMING OF SERIAL CONVERSION

	TIME	t_1	t_2	t_3	t_4	t_5
MSB first	A (Undelayed)	1^{MSB}	0	1	1^{LSB}	
	B (Delayed)		1	0	1	1^{LSB}
	S (Sum)	1	1	1	0	1^{LSB}
	Answer in Gray Code (discard LSB)	1	1	1	0	
LSB first	A (Undelayed)	1^{LSB}	1	0	1^{MSB}	
	B (Delayed)		1	1	0	1
	S (Sum)	1^{LSB}	0	1	1	1
	Answer in Gray Code (Discard LSB)		0	1	1	1^{MSB}

The dropping of the least-significant bit can be performed by the gate shown at right in Fig. 1.

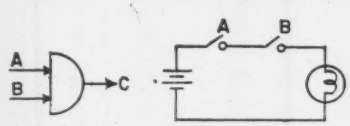
In some cases, the least-significant bit appears first, followed by the more-significant bits. When this occurs, the same process (delay and add without carry) is performed, and the *least-significant bit is again dropped*. In this case, however, the least-significant bit is the first bit, as shown at the bottom in Table 2. Note that the output (cyclic equivalent) also has its least-significant bit presented first (at time t_2 in this case). In other words, if the inputs have LSB first, the output will have LSB first. If the inputs have MSB first, the output will have MSB first.

Hardware sometimes can be saved by presenting the most-significant bit first (or last). A bit reversal technique can be used to obtain either one desired.

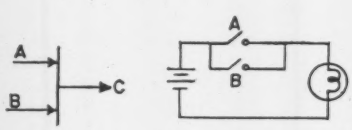
The converter of Fig. 1 is packaged on one 2½" x 5" card employing standard Control Logic Weld-modules such as those shown in Fig. 2.

FIG. 2. TYPICAL CIRCUIT card and weld-modules that feature all-welded connections.

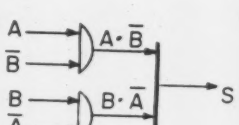
REFRESHER ON SYMBOLIC-LOGIC FUNDAMENTALS



AND gate symbol, and switch analogy for A AND B = C, written as $A \cdot B = C$.



OR gate symbol, and switch analogy for A OR B = C, written as $A \vee B = C$.



EXCLUSIVE OR produces an output when either input is present, but not both. This can be expressed $S = A \cdot \overline{B} \vee B \cdot \overline{A}$. This (S) term is the sum output of a half adder.

HYSTERESIS-RING memory-drum motor (courtesy Hydro-Aire Co.)

MOTOR DRIVES FOR MEMORY DRUMS

STANLEY A. CORY
Hydro-Aire Company

Installment 11 in memory series discusses features of different types of driving motors

DRUM DRIVES usually fall into two types—synchronous or non-synchronous. Originally it was thought that synchronous speed would be essential for accurate memory operation, but increasing experience with improved methods of timing has shown that non-synchronous operation is acceptable.

Rotor and stator assemblies are designed for a-c operation only, either for 60 or 400 cycle operation. While it is difficult to establish an "average" speed of operation, a range of 3000 to 8000 rpm is encountered most frequently. Supply voltage can be single, two or three phase.

Stators vary from about 3½" to 8" outside diameter and are basically similar. The important differences are in the rotors.

Non-Synchronous Motors

Non-synchronous drum motors follow normal induction-motor design practice. As in almost all memory-drum motors, the diameter is large in relation to the length of stack. This gives the appearance of a pancake motor, but without the axial air gap usually associated with this type of motor. The rotor might have either a single or double cage to give the desired starting and slip characteristics.

Variable-speed motors use a double-cage rotor operated in conjunction with a special stator winding and a servo-controlled brake. The motor is designed for high slip, and then over-excited to hold speed constant against the servo-controlled brake.

Synchronous Motors

Synchronous drum motors can be classified under four headings:

1. Reluctance type
2. Hysteresis ring
3. Slotted hysteresis ring (with or without cage)
4. Permanent-magnet slotted hysteresis ring

Reluctance type motors use the orthodox induction rotor. Flats or slots equivalent to the number of magnetic poles are milled across the periphery. The rotor is designed for minimum slip due to the difficulty encountered in a reluctance rotor pulling itself into synchronism. The torque available at this point is small in relation to the running and starting torques. Therefore, reluctance rotors usually are not used on high-inertia drums. However, if limitations of pull-in torque are carefully considered in design, there should be an increasing application for reluctance type motors.

Hysteresis ring rotor is an annular ring of permanent-magnet material, such as Cobalt 81 or 83. Design of a hysteresis ring rotor is critical; little published material is available. Calculations must be precise, and experimental work is nearly always necessary. Torque of a hysteresis rotor is relatively constant from stall, through pull-in, operating, and pull out. Usually a hysteresis rotor will synchronize any load it is able to start. It will run at synchronous speed, but not with definite polar orientation. It has reasonable damping, but poor efficiency and power factor, and the speed may drift slightly under heavy loads.

Slotted-hysteresis-ring rotor is built up from stamped cobalt sheet. A tooth-and-slot form is incorporated that resembles an induction-rotor stamping. A cobalt material is essential, and the electrical design of the rotor core area is critical. The slot-and-tooth lengthen the flux path, resulting in greater torque output from a given diameter, which is particularly noticeable as the number of magnetic poles increases. Torque can be increased further, even with the minimum number of poles, by fitting an orthodox cage into the rotor slots.

The slotted-hysteresis-ring rotor will start with the vigorous torque of the induction motor and run with the synchronism of the hysteresis motor. Addition of the cage will increase the starting torque and aid damping. But the efficiency and power factor are lower than the hysteresis motor and, while the speed drift is less, it will not lock-in with definite polar orientation.

Permanent-magnet slotted-hysteresis-ring rotor is identical to the slotted-hysteresis-ring rotor, except that it has a permanent magnet inside it. This permanent magnet has the number of magnetic poles for which the stator is wound. This type of rotor combines the advantages of the induction, hysteresis and dc-excited synchronous motors. It starts with the vigorous torque of an induction motor. As the speed approaches synchronism and the cage effect falls off, the cobalt material in the rotor laminations will accelerate the rotor into synchronism. Immediately before true synchronism is reached, the permanent magnet "snaps" into its true polar position in relation to the stator windings. Thus a two-pole rotor always will pull into true synchronism in a predetermined polar relationship. Pull-in and pull-out torque are increased considerably by the magnet. This type of rotor also has good damping, steady acceleration with definite polar orientation, and high efficiency. It cannot be made as a dual-speed motor, and starting current might be several times the running current.

Applications

The five types of motors described cover virtually 100% of memory drum applications.

Non-synchronous induction motors are suitable (1) for lower-cost computers with either contact or non-contact heads, (2) where constant-speed operation is not required, and (3) where a stable voltage condition exists.

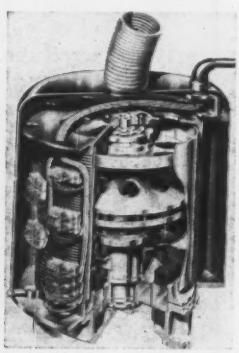
Reluctance type motors are used (1) in lower-cost computers with relatively low-inertia drums, (2) where synchronism is necessary, and (3) where supply voltages are stable and have ample capacity for momentary overloads.

Hysteresis ring motors find uses where (1) drum inertia is low, (2) synchronous speed is desired, (3) some voltage instability might occur, and (4) a low-cost motor is required.

Slotted-rotor hysteresis ring motors (with or without a cage) are particularly desirable in slow-speed, high-frequency applications where good starting and running torques are required.

Permanent-magnet slotted-rotor hysteresis motors might be incorporated in high-inertia, contact-head-start drums where voltage input is unstable. They are useful in airborne computers where sudden shock or directional change might tend to throw the orthodox type of motor out of synchronism.

The types of motors described are not unduly difficult to manufacture, but close attention must be paid to fits, tolerances, air-gap clearance and balance. Nearly all applications require different design parameters.



SECTION through memory drum with motor built into base (courtesy Litton Systems).

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Mass Spectrometry in Science and Industry

The dependability of sensitive mass spectrometric analysis in process control, laboratory analysis, and research is one of the major scientific contributions of our time.

GAS AND LIQUID analyses which formerly took days are now completed in minutes by automatic mass spectrometry and computation. The mass-spectrometer principle is based on sorting of components according to molecular weight or mass, and then counting them. Such a direct approach is independent of other properties of the molecule.

Fig. 1 illustrates this principle. As described in point *d*, every molecule has a unique and constant fragmentation pattern when subjected to electron bombardment. Each type of molecule will break when bombarded by electrons, and form a quantity of positive ions(depending on the relative strength of the atomic bond). These positive ions are accelerated, diverted into a circular path, collected, and measured by an electrometer tube, giving a record of the number of ions of a given mass.

The permanent record of the quantities of components analyzed is called the "mass spectrum" of the sample. In order to be ionized, the compound has to be in the gas phase, so that this record can be said to show every volatile constituent present (within the analysis range of the instrument).

Many models now are available, from large analytical types intended for laboratory use to smaller and portable "process-monitor" types intended primarily to monitor and control continuous processes in chemical plants and oil refineries.

Applications

Some of the active areas of interest are:

1. Electronic Tube Research
   a. Analysis of gases evolved during tube operation.
   b. Analysis of pumping by getters.
2. Evaporator Work
   a. Residual gases in vacuum systems.
   b. Evaluation of various types of vacuum systems and outgassing data for different material.
3. Pump and Trap Performance
   a. Speed of ion pumps for various gases.
   b. Speed and efficiency of getters.
   c. Efficiency of cold traps for various molecules.
4. Nuclear Research
   a. Monitoring He from radioactive decay.
   b. Measurement of C^{14} in isotope analysis.
5. Military and Space Research
   a. Analysis of atmosphere at high altitudes.
   b. Monitoring of He and other gases in evacuated and helium filled microwave conduits for remoted firing of atomic weapons.
   c. Monitoring He, H, H_2 and H_3 in production of hydrogen isotopes.
   d. Space simulation—analysis of residual gases from parts subjected to thermal variations, shock, and nuclear or cosmic radiation.
6. Cryogenics
   a. Monitoring gases in vacuum insulating jackets.
   b. Monitoring oxygen contamination in liquid hydrogen.
7. Metallurgy
   a. Evolved gases in vacuum melting and casting.
   b. Evolved gases in annealing and extraction.
8. Physical and Chemical Research
   a. Research on electrical discharges in gases.
   b. Research on catalysis at low pressures.

Use in Petroleum Refining

Petroleum plants use the mass spectrometer to analyze gas samples from the plant streams up to the pentane hydrocarbon range, to analyze liquid hydrocarbons and gasoline fractions up to 400°F, and for hydrocarbon "type" analyses.

For example, two mass spectrometers are playing a prominent role in both process control and research work at Shell Oil Company's Houston, Texas process-development laboratory. This laboratory is the central clearing house for 40 pilot plants in the firm's research department.

A mass spectrometer used by the Universal Oil Products Co., Riverside, Ill., analyzes about 600 samples each month. Eighty percent of these are mixtures of petroleum

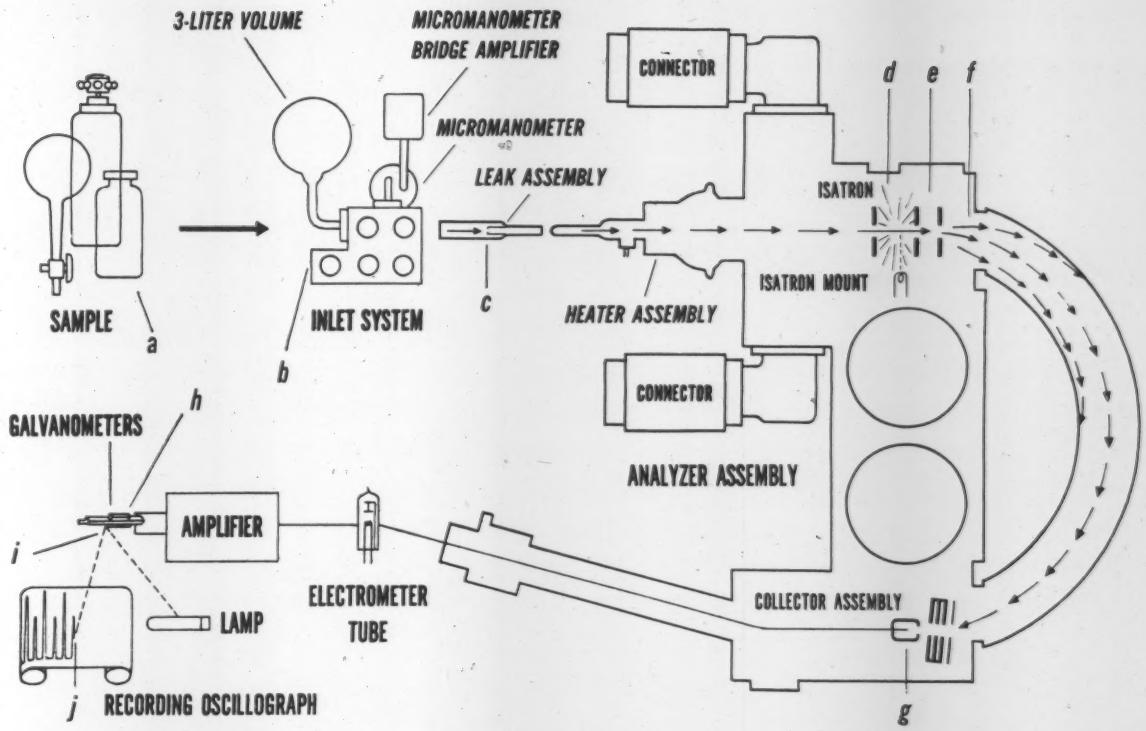


FIG. 1. HOW THE MASS SPECTROMETER WORKS.

a. A sample of the unknown substance is stored in a small container at relatively low pressures, usually in the vapor phase.
b. The molecules are introduced through a series of special valves called the inlet system.
c. The conglomerate mixture of molecules passes through a restriction called a gold leak. The tiny openings pass only a limited number of molecules.
d. In the ionization chamber, called the Isatron, a much higher vacuum is maintained. Here the molecules are bombarded with a stream of electrons from a heated filament. Of the ions formed, only the positive ions are of interest.
e. Ions thus formed leave the Isatron chamber through a narrow slit. They are next accelerated to a high velocity by a strong electrostatic field, and pass through a second slit.
f. A magnetic field, parallel to the slits, diverts the fast-moving ions into circular paths, the radii of which are proportional to the mass and velocity of the ion. Thus, the single beam is split into individual beams, the lighter particles curving the most.
g. Sorted in this manner, ions of a given mass pass through resolving slits and strike a collector 180° away from their starting point. The charges given up to the collector are amplified by an electrometer.
h. Having now been translated into an electric signal, the results are amplified and fed to a bank of five galvanometers, each set for a different sensitivity.
i. A tiny beam of light reflected from each galvanometer mirror is photographed on a moving roll of sensitive paper in the oscillograph.
j. Thus, the complete mass spectrum is obtained by focussing the separated ion beams successively on the collector by varying the ion-accelerating voltage.

gases containing as many as 19 compounds.

Another mass spectrometer is used at Sinclair Research and Development Laboratories, Harvey, Ill., for rapid examination of gases and highly volatile petroleum products. Mixture samples are analyzed quickly that would require hours to run by classical distillation methods.

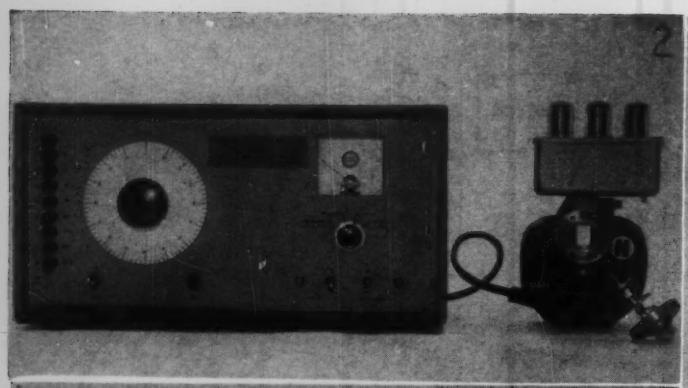
Continuous Analysis in Catalytic Reforming

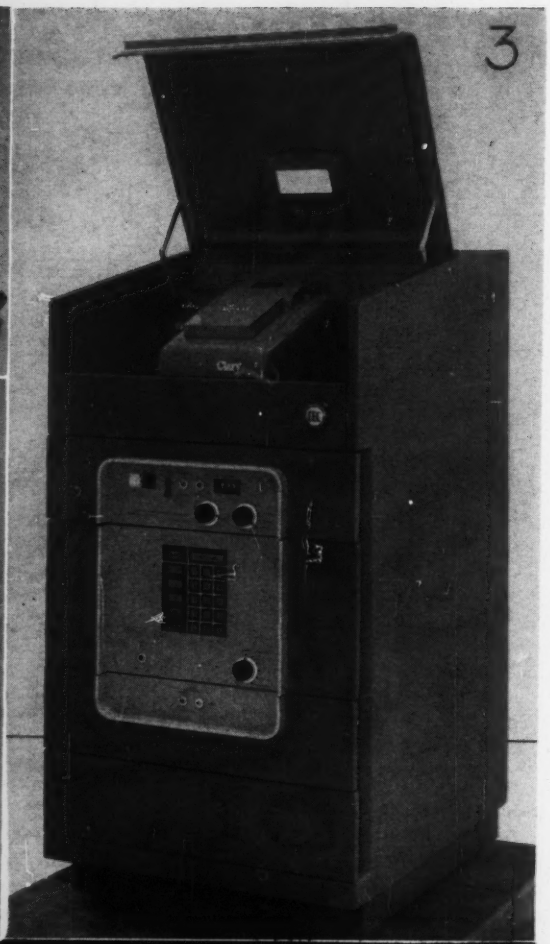
An interesting application of mass spectrometry is in catalytic reforming at the Esso Laboratories' pilot plant at Baton Rouge, Louisana. Esso researchers say that continuous analysis of product streams by the Process-Monitor Mass Spectrometer (CEC) in connection with other continuous analyzers and data reduction systems has proved of immeasurable assistance in obtaining continuous, almost instantaneous analytical data.

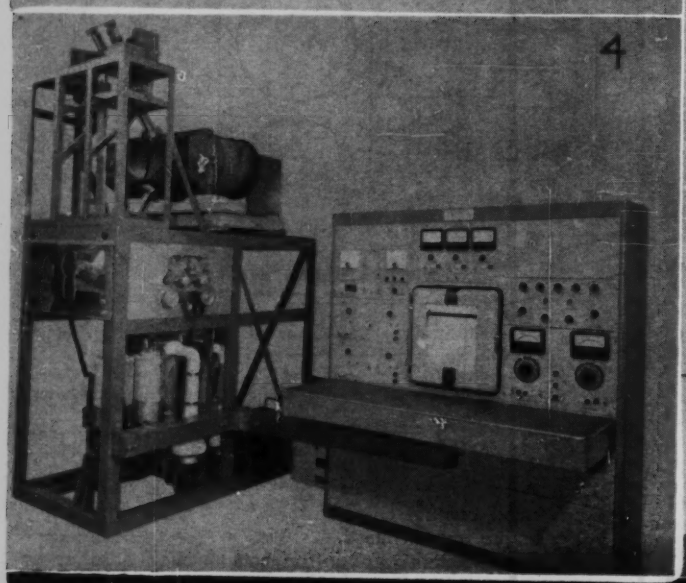
At Petroleum Chemicals, Inc., in Lake Charles, La., a continuous mass spectrometer analyzer has provided substantial gains in operating efficiencies in the production of ethylene. The instrument is in multi-stream service on the outlets of four ethane cracking furnaces. The people at PCI chose mass spectrometry over other methods because of its versatility, speed and accuracy, selectivity of analysis, and ease of calibration. Previous furnace control had been based on temperature control alone, but this type of inference control could not satisfactorily track varying operating conditions, feed stock composition changes and physical variation within the furnace itself.

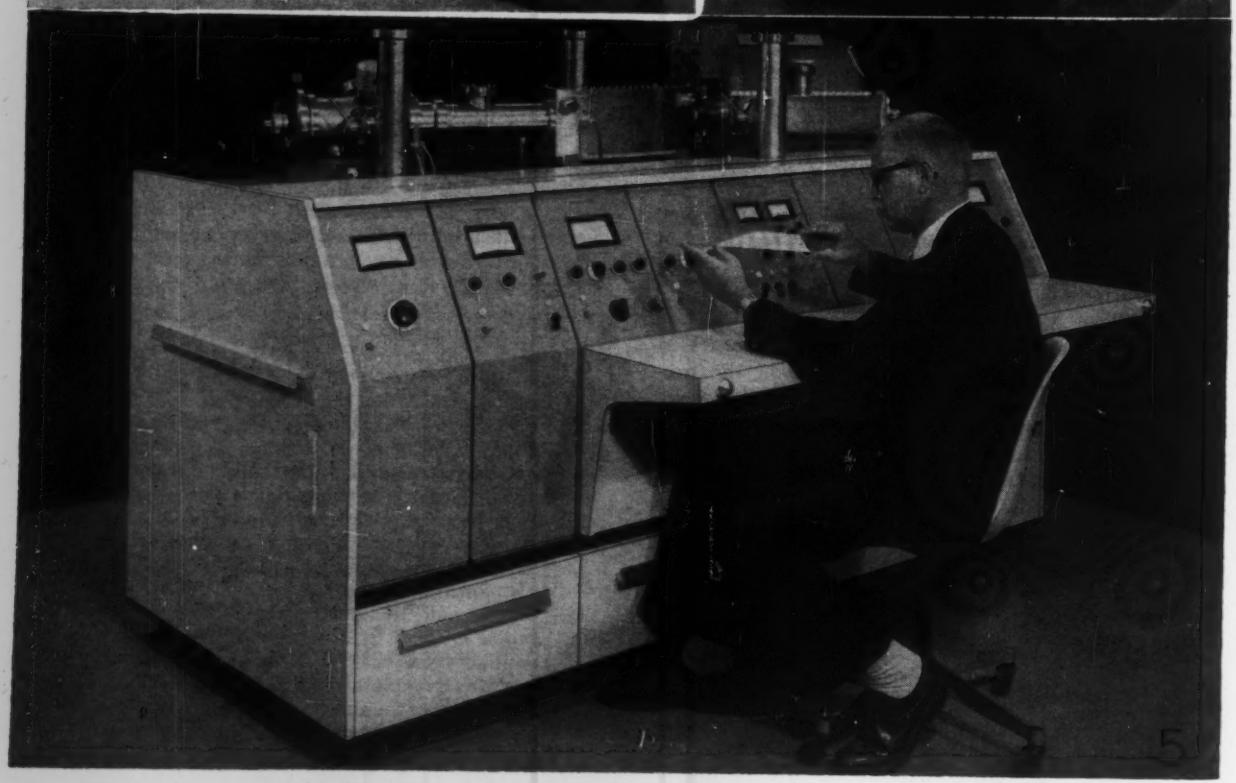
Residual Gas Analyzer

A new application of this principle has resulted in the Residual Gas Analyzer, designed for continuous analysis









of gases remaining in evacuated systems. Fig. 2 shows the modular construction, with the ion source and magnet making up the analyzer at the right, and the control electronics at the left.

When installed on the system to be monitored, the Residual Gas Analyzer is capable of measuring minute quantities of gas, gaseous mixtures, and vapors over a mass range of m/e 2 to 80. Resolving power is sufficient to separate adjacent peaks up to mass 20. The instrument's high-sensitivity makes possible, in many cases, the analysis of residual gases in the range of 10^{-4} to 10^{-9} mm Hg pressure.

A large dial on the control unit is inscribed with the mass numbers. As the analysis progresses, the dial automatically turns to indicate the mass being scanned. This dial can be manually advanced or turned back by the operator for selective analysis of specific peaks, and the instrument can be set by this means to start or stop at any point on the spectrum. A programmer accessory is available to automatically attenuate and control the scan of a pre-selected series of masses.

A-D Converter

To facilitate the computations required in determining component concentration, an analog-to-digital converter has been developed as shown in Fig. 3. This device, known as the MASCOT, converts the peak amplitude from the ion-current amplifier and the instantaneous, ion-accelerating voltage into decimal-digital form. It then actuates readout devices which tabulate these values. The output is an 8-digit decimal number which indicates true mass number, peak amplitude scale factor, and relative peak height.

Air Pollution

The unique ability of the mass spectrometer to pinpoint specific chemical compounds makes it the perfect "sleuth" for ferreting the sources and composition of air pollutants. The County of Los Angeles identified about 60 chemical compounds or families of compounds in samples of air with the mass spectrometer; the amounts of some of these were determined. It was shown that the gaesous phase of their smog was primarily in a mixture of hydrocarbons and other substituted compounds.

FIG. 2. RESIDUAL gas analyzer.

FIG. 3. MASCOT, showing tape printer.

FIG. 4. NEW spark-source mass spectrometer.

FIG. 5. HIGH-PRECISION instrument for isotope research studies.

Auto Engine Exhaust

The mass spectrometer has been used successfully for the analysis of exhaust-gas samples, but a major problem has always been the obtaining of a representative, discrete sample.

The sample is now taken from a point on the exhaust manifold approximately one foot downstream from the nearest exhaust port. A short, ¼" line delivers the sample directly to the instrument eliminating the discrepancies which result from use of sample containers. The investigations have been enlightening because the results showed not only how the automobile is a source of smog, but also because they provide a means of studying engine efficiency.

Medical Research

Probably the most dramatic uses of both the process monitor type and a special "isotope-ratio" type of mass spectrometer are in biological and medical research. The isotope-ratio instrument and radioactive or enriched, stable isotopic materials have put new methods at the disposal of researchers in biochemical and physiological fields. Cell growth and metabolic processes could not be followed prior to the availability of isotopes.

Researchers at the University of Wisconsin, for example, have been using an isotope-ratio instrument since 1950 to study the mechanism of biological nitrogen fixation. At the Veterans Administration Medical Center in Los Angeles, a mass spectrometer has been used to assist in water-balance studies and research on human water-metabolism.

An interesting application of the mass spectrometer to the study of blood gas equilibria during anethesia was made by two researchers at the Mayo Foundation, Rochester, Minnesota, who developed simple techniques for the analysis of anesthetic and other gases in the blood, notably carbon dioxide and oxygen.

Another contribution of mass spectrometry in the medical field is in breath analysis involved in lung efficiency studies for the determination of "wash out" time of the lungs for different components. In this way, doctors can determine precisely how much of a patient's lungs can be safely removed and still leave enough for normal functioning.

Space Age

Mass spectrometry is also contributing to space-age materials-research programs. Components used in missiles and associated support systems must be of the utmost metallurgical purity. The electronics are practically all solid-state type where semi-conductor purity is essential.

To provide a completely integrated approach to materials-research programs, two new mass spectrometers have been made available. Fig. 5 shows an instrument featuring a spark ionization source, providing both high sensitivity and a wide dynamic range.

The other analyzer (Fig. 4) incorporates either a Knudsen-type cell or a thermal ionization source. With the former, high sensitivity may be realized in, for example, monitoring high temperature reactions in solid materials. With the latter source, high-precision studies can be made in isotopic assay work involving uranium isotopes or other metallic isotopes.

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION

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BOILER COMBUSTION CONTROL SYSTEMS

J. W. ROTH
Bailey Meter Company

The two basic combustion control systems are (1) series, in which the fuel controls the air, or vice versa, and (2) parallel, in which fuel and air are controlled simultaneously by the load. The advantages of each are achieved by use of parallel control with readjustment from fuel/air ratio. Characterization of the control elements is described.

COMBUSTION CONTROL is concerned with the application of fuel and air to a furnace. The fuel flow rate required is a function of load, and the air flow rate required for supporting combustion is a function of fuel flow rate. Fig. 1 illustrates this relationship. A measurement of load could control fuel flow and a measure of fuel flow could control air flow.

There always will be some time lapse while large pumps and fans change speed. If air is ratioed to the fuel it is possible for the air to be insufficient for efficient combustion during this interval. Hence it is common for the fuel to be ratioed to the air. This is cascade, or series, control.

A parallel control system is one in which both fuel and air are controlled by the same (load) measurement simultaneously (Fig. 2).

Air Control

The optimum in air control is achieved when at all times just enough air is applied to completely burn all of the fuel. Any air quantity above this amount results in a loss of efficiency due to the heat absorbed by the unused air. Air below this amount will result in loss of efficiency due to loss of heat resulting from incomplete combustion of fuel. Extended firing under such conditions can lead to formation of explosive mixtures within the furnace.

Therefore, it is important that air control be established so that there will always be sufficient air for complete combustion. The result is that operation always is carried out under conditions of higher-than-required excess air. This undesirable feature constitutes the chief limitation to a parallel-type control system.

Hence, control of air should include a measurement of excess air. In fact, the air flow should be adjusted to maintain the correct fuel-air ratio, as shown in Fig. 1. The advantages of both a parallel system (speed of operation) and series or cascade operation (proper fuel/air ratio) can be achieved in a system called Parallel Control With Readjusment (of fuel air ratio), as shown in Fig. 3.

Load Measurement

The load for a stream generator-turbine unit could be measured by steam flow, generator megawatt load, or steam pressure. The steam pressure is used most commonly as a load index.

However, since steam pressure cannot reflect load-fuel unbalance until such time as the load has already changed, it is common to use either a measurement of steam flow or megawatt load as an *anticipation index* in conjunction with steam pressure (Fig. 4). Such an anticipation index makes it possible for the system to reach equilibrium in a shorter period of time because

January Meeting: Thursday, Jan. 18, 8 PM; Rio Hondo Country Club, S. Old River Rd., Downey, Calif. $2.50.

Subject: Air Pollution and Disposal of Refinery Waste Gases—Donald F. Walters, County of LA, Air Pollution Control District, also Repairing and testing modular solid-state electronic devices.

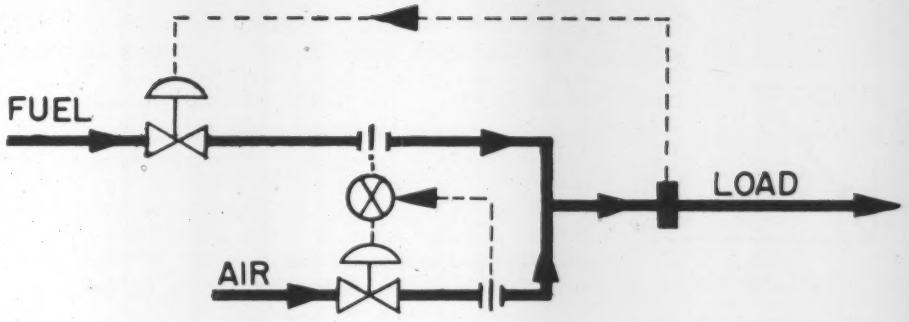


FIG. 1. SERIES, or cascade, control circuit. Fuel flow controls air flow.

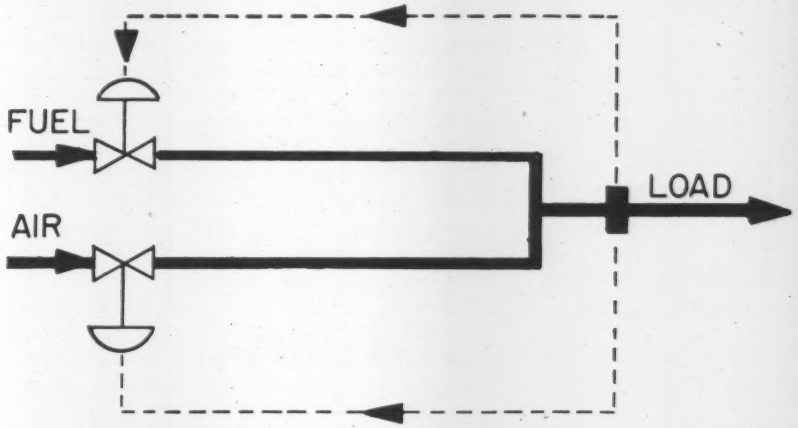


FIG. 2. PARALLEL control circuit. Fuel and air flow are controlled simultaneously by the load.

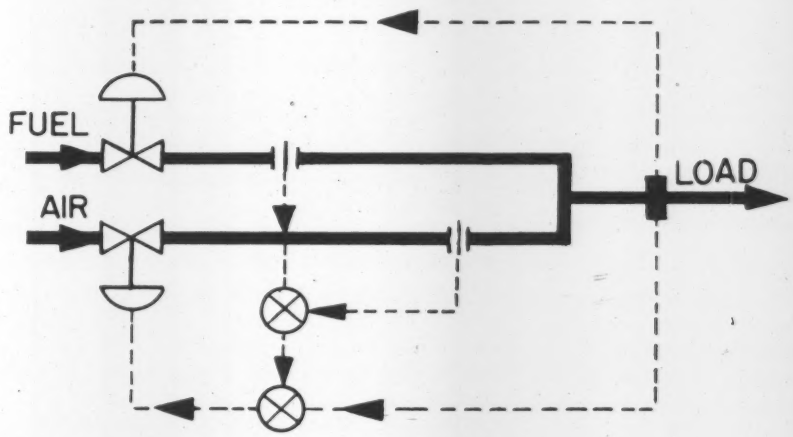


FIG. 3. PARALLEL control system with readjustment of fuel/air ratio.

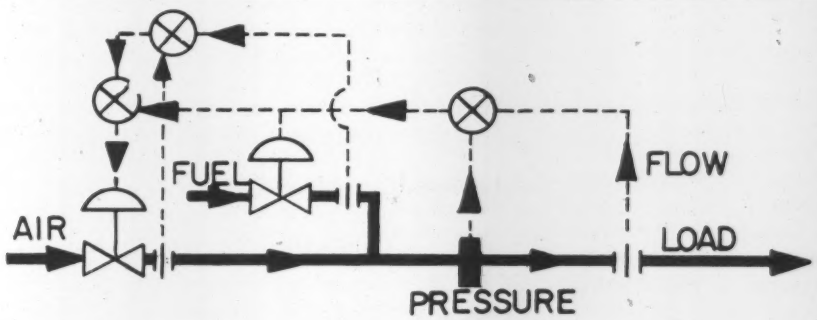


FIG. 4. USE of both steam pressure and steam flow rate as load index.

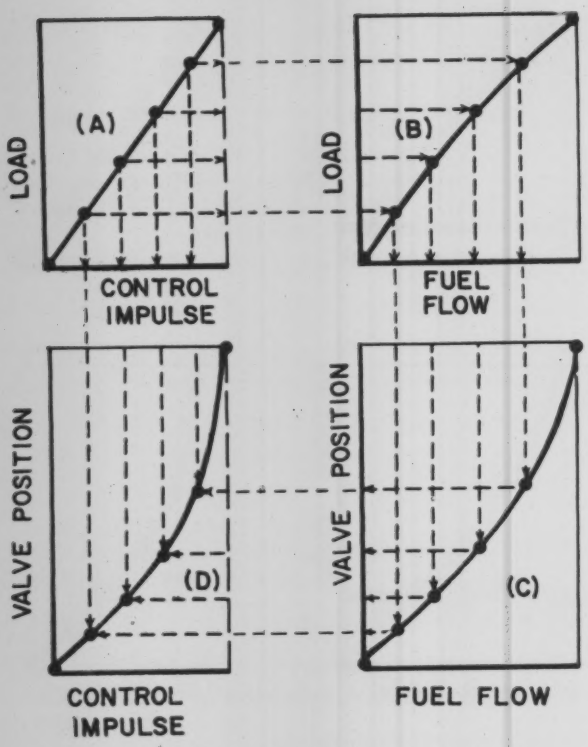


FIG. 5. OBTAINING the characteristic curve (D) of control impulse versus valve position from given curves of fuel versus load (B) and valve characteristic (C).

any load-fuel unbalance is detected and corrected sooner, the result being less over and under firing.

Calculation of theoretical air for combustion plus an allowance for incomplete mixing (theoretical air plus excess air) would not necessarily assure satisfactory furnace conditions because of combustion factors. Ultimately, the desired air flow for any given fuel quantity must be established on the basis of actual furnace conditions as revealed by flue gas analysis. The air flow measurement can be made by (1) measurement of the differential pressure drop across a venturi or segmental orifice in the air ductwork, or (2) by the differential pressure drop across the furnace itself.

Characterization

A *parallel control* system depends on *characterization* because the load signal is used to position two "valves" (fuel and air). The resulting flow of fuel and air depends on the characteristics of the valves (the curve relating fluid flow *vs* valve position). Note that the combustion also is affected by temperature, inlet pressure, pressure drop, specific gravity, viscosity, BTU/cu ft of fuel, etc., as well as by the characteristics of the control elements. However, characterization of the control elements is the starting point for control-system design and use.

Fig. 5 shows a way of relating (characterizing) the fuel characteristics to the load impulse. The same thing can be done for the air-control system.

For any given load, the control impulse and fuel flow are determined from curves (A) and (B), respectively. From the fuel valve characteristic curve (C), the device position corresponding to a given flow is determined. A plot of device positions *versus* corresponding control impulses results in curve (D), which shows the desired relationship between position of the fuel valve and the control impulses. A cam-operated positioner can provide an easy means for establishing the relationship shown in Fig. 5D.

Forced and Induced Drafts

Air control on many large steam-generating units consists of two parts—that of forced-draft fan control and induced-draft fan control. The forced-draft fan pumps air into the furnace; the induced-draft fan pumps air from the furnace, forcing it up the stack. In the average application, air quantity is controlled with the forced-draft fans, and furnace draft is controlled with the induced-draft fans.

When induced-draft fans are used, it normally is desired to maintain a constant slightly negative pressure in the furnace regardless of load. Hence, the control of induced draft uses a measure of furnace draft for readjustment. A change in forced draft will require a change in induced draft, in order that the furnace draft remain constant. Parallel control is therefore applied to both fans.

Fig. 6 shows the resultant combustion control diagram for a modern steam generator burning oil with forced and induced draft fans.

In Fig. 6:

1. Steam flow changes are reflected by changes in fuel, forced draft, and induced draft.
2. Steam pressure changes are reflected by readjustments in fuel, forced draft and induced draft.
3. Fuel-air ratio changes are reflected by readjustments in forced draft and induced draft.
4. Furnace draft changes are reflected by readjustments in induced draft.

Readjustments will be required from time to time due to the inevitable changes in the load-fuel relationship and load-air relationships. However, readjustment may be kept to a minimum by careful characterization of the fuel and air control devices.

The system is typical and illustrates the principles involved. There are many variations to accommodate specific operating objectives and variable characteristics of auxiliary plant equipment being controlled. For example, the combustion control arrangement for any given job might be influenced by factors such as multiple fuel firing, variable-BTU fuels, variable-speed fans, range of operation, rate of load change, etc. Complexity, initial cost, efficiency, and safety also must be considered.

Combustion Control System

Fig. 6 shows an automatic combustion control system, illustrating the comprehensive design which characterizes the entire installation.

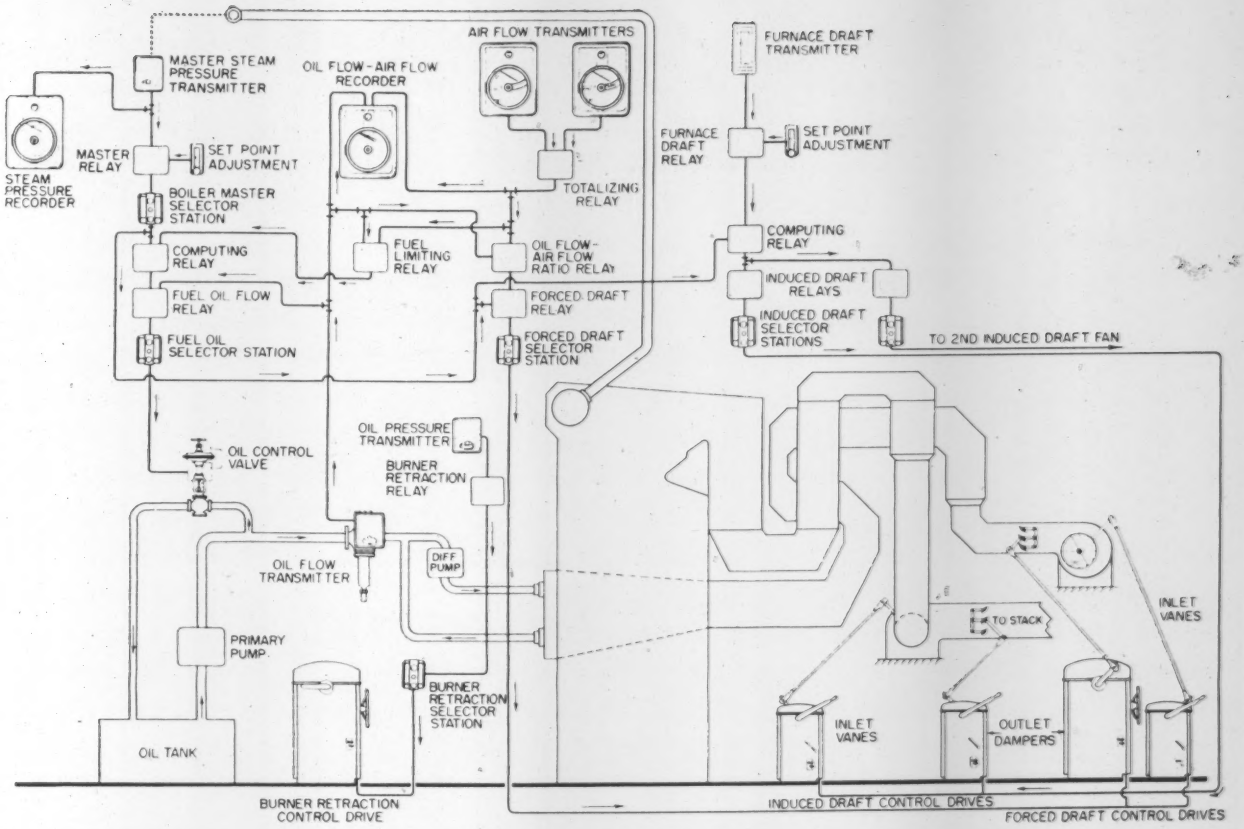


FIG. 6. COMBUSTION CONTROL SYSTEM. Master signal, generated by Master Steam Pressure Transmitter at upper left, is sent to Computing Relays (one for fuel-flow and one for air-flow control). Fuel-oil Limiting Relay modifies the control signal to the fuel-flow controller in event of deficiency of combustion air.

The combustion control system operates in the following manner:

1. *Master Control*: A Master Steam Pressure Transmitter controls the fuel-oil flow, the forced-draft fan and induced-draft fans in parallel and in the approximate desired relationship to each other. Oil flow is regulated by a recirculating valve, and each fan by both inlet vanes and outlet dampers.

2. *Fuel Oil Limit Control*: A fuel limiting signal modifies the master control impulse so as to retard the fuel-oil flow in event the fuel/combustion-air ratio reaches an established limit .This phase of the control system is a safety feature which minimizes the possibility of firing with an extreme deficiency of combustion air at time of rapid load change or in event of a sudden loss in fan capacity.

3. *Oil-Flow/Air-Flow Ratio*: The master control impulse is readjusted to its final control of the forced draft fan from a signal established as a function of the ratio of the metered fuel and combustion-air flows.

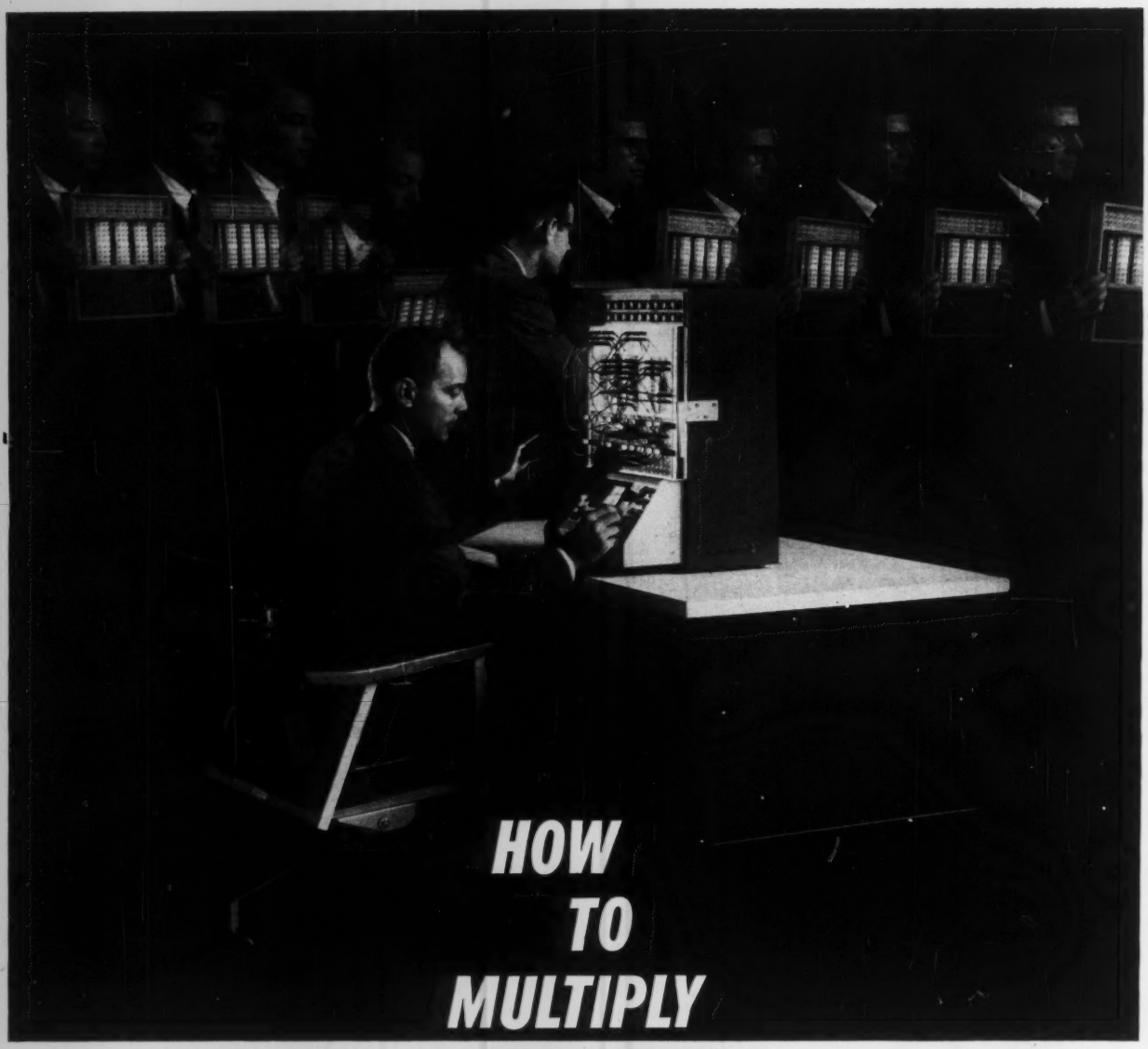
4. *Furnace Draft*: So as to maintain the desired balance between the induced- and forced-draft fan capacities, a Furnace Draft Controller initiates a readjusting control impulse which modifies the master signal in its control of the induced-draft fan.

In addition to the master steam pressure signal and modifying signals mentioned, a pneumatic signal from an Oil Pressure Transmitter controls burner retraction to maintain the desired oil-burner position.

Selector Stations in the control room provide manual control of oil flow, burner retraction, forced draft, and induced draft. A selection switch for "bumpless" transfer from hand to automatic operation is an integral part of each selector station.

In addition to the combustion control and metering equipment described, the Bailey Meter Company also supplied the following control systems:

1. *Air-operated Three-element Feedwater Control.*
2. *Air-operated Fuel-Oil Temperature Control.*
3. *Air-operated Hydrogen Temperature Control.*
4. *Electrically-operated Feedwater-Pump Recirculation Control.*
5. *Air-operated Air Recirculation Control.*
6. *Air-operated Deaerator Level Control.*



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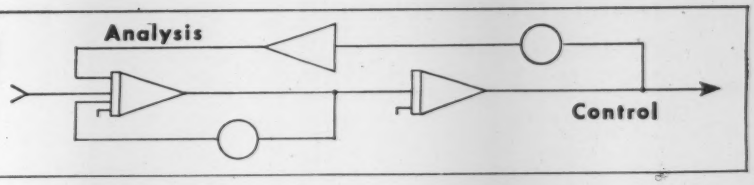

Newsletter

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Bits

Under **Pieces** we have:

Midwestern Simulation Council Meeting of 10 July 1961

"End-Point Temperature Control of the Basic Oxygen Steelmaking Process by Means of a Special-Purpose Analog Computer" by *W. J. Slatosky* and *N. F. Simcic* (both of Jones & Laughlin Steel Corp.)

"Simulation of Extremum Adaptive Control System" by *R. I. Van Nice* (Westinghouse Electric Corp.)

"Simulation of Continuous Slab Heating Furnaces" by *A. H. El-Waziri* (U.S. Steel Corp.)

"Study and Simulation of Continuous Processes on a Hybrid Computer" by *K. H. Bhavnani* (Westinghouse Electric Corp.)

Rocky Mountain Simulation Council meeting of 30 September 1961

A. I. Katz (Electronic Associates Inc.) on the use of computers in education.

I. L. Hebel on the use of computers at the Colorado School of Mines.

H. R. Warner on research on the circulatory system being carried on at the L.D.S. Hospital in Salt Lake City.

Analog Techniques by *Tom Anderson* (Lockheed)

SCI Activities—announcements from the Eastern, Western, and Southeastern Simulation Councils

Information Without Theory

The 2nd Annual San Diego Symposium on Biomedical Engineering; possible reprinting of back issues of the *Newsletter*

Letters

G. E. Wentworth to *Jack Sherman*
Tom Anderson to your Ed
Bob Horwitz to your Ed
Circular letters from *Dave Miller*
Milt Aronson to your Ed

Pieces

MIDWESTERN S/C MEETING OF 10 JULY ON STEELMAKING AND SLAB HEATING

On 10 July, 1961 the Midwestern Simulation Council held a joint meeting with the Pittsburgh chapter of the IRE Professional Group on Electronic Computers at the United States Steel Research Center, Monroeville, Pennsylvania.

As each of two correspondents thought the other was gathering material for your *Newsletter*, your Ed is probably lucky to be able to report on this meeting at all. As it is, we haven't yet received anything but pictures and comments on the first paper, "The Application of Process-Control Computers in the Steel Industry" by **T. R. Schuerger** (U.S. Steel Corporation). They are out of context, so we will hold them—just in case.

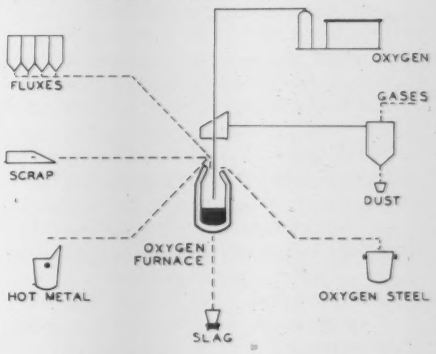
The second paper we give you practically as received because we found it interesting and believe you will.

END-POINT TEMPERATURE CONTROL OF THE BASIC OXYGEN STEELMAKING PROCESS BY MEANS OF A SPECIAL-PURPOSE ANALOG COMPUTER

by W. J. SLATOSKY and N. F. SIMCIC
(Jones & Laughlin Steel Corporation, Aliquippa, Pennsylvania)

THE BASIC OXYGEN furnace plant is a recent addition to the steelmaking facilities at the Aliquippa Works of Jones & Laughlin Steel Corporation. Steel made by this process is comparable in quality to that of open-hearth grades, and production rates are in excess of 100 tons per hour.

Steel is processed in one of two trunnion-mounted cylindrical furnaces lined with basic refractories (Fig. 1). The furnace is charged with scrap, hot metal from the blast furnace, and fluxing materials consisting of burnt lime, mill scale, and fluorspar. After



FLOWSHEET OF TYPICAL OXYGEN CONVERTER PROCESS

FIG. 1. OXYGEN converter.

TABLE I—CHARGE EQUATIONS

EQUATIONS FOR CALCULATING CHARGE ADDITIONS

$$W_{scrap} = \left[W_{charge} \left(\left[117.93 - 25.3\ V.V. \right] \left[Si\% \right] + 29.41\ Mn\% + 0.257\ T_M - 502.19 \right) + 1.8 \times 10^6\ V.V. + 16.22 \times 10^6 - 3125\ T_M - 96.3 \times 10^6 \left[-75 \times 10^{-5}\ L.H. + 0.153 \right] - 1808 \left[W_{scale} + W_{ore} \right] \right] \div \left[\left[117.93 - 25.3\ V.V. \right] \left[Si\% \right] + 29.41\ Mn\% + 0.257\ T_M + 93.82 - 1285 \left[-75 \times 10^{-5}\ L.H. + 0.153 \right] \right] - 67\ t_D$$

$$W_{H.M.} = W_{charge} - W_{scrap}$$

$$W_{CaO} = \left(\frac{60}{28} \right) \left(V.V. \right) \left(\frac{Si\%}{100} \right) \left(W_{H.M.} \right) \left(\frac{1}{0.92} \right)$$

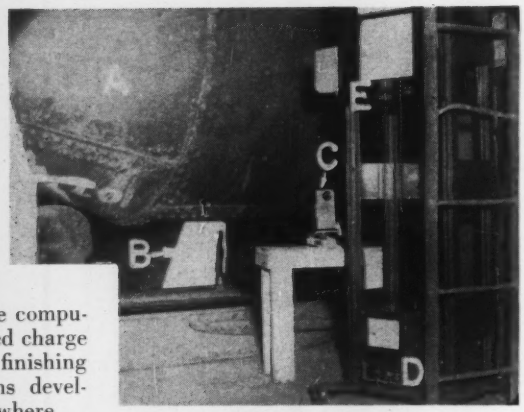


FIG. 2. PYROMETER (C) sights on molten iron (B).

FIG. 3. EAI computer.

completion of the charge, the furnace is turned up and a water-cooled lance is lowered to a predetermined position above the bath. From the tip of the lance, a jet of high-purity oxygen with a flow rate of 6500 cfm is directed vertically at the bath, thus initiating the thermochemical reactions of the process.

The reactions consist of the oxidation of carbon to carbon monoxide and carbon dioxide; the formation of oxides of iron, silicon, manganese, and phosphorous in the slag; and the transfer of sulfur from the metal to the slag phase. The heat is completed in about 20.5 minutes and is determined by a visual drop in the flame issuing from the mouth of the vessel. The furnace then is turned down and a bath temperature reading is taken with an expendable-tip immersion thermocouple.

If the temperature is within the range of 2880° to 2920°F, the heat is ready for tapping. If it is too hot, scrap is added as a coolant; and if the heat is cold, it is reblown for a suitable period of time. When the desired temperature is obtained, the heat is tapped into a ladle. Certain ferro-alloy materials are added to effect the desired composition. Upon completion of the tap, the furnace is turned toward the charging floor and decanted for slag removal. The furnace is then ready to repeat the cycle.

The Temperature Control Problem

If the finishing temperature of a heat is not within the specified range, it must be adjusted before being tapped. Otherwise, pouring difficulties are likely to ensue. Such adjustments are time consuming and costly. Approximately 45% of all heats normally are delayed for temperature adjustment; 55% are within range.

Temperature adjustments can be avoided if the furnace is charged with the proper proportions of scrap, lime, and hot metal.

In an attempt to improve the 55% performance level, a thermochemical analysis of the process was undertaken. From this analysis, expressions were developed which enable computation of a thermally balanced charge that results in the desired finishing temperature. The expressions developed are shown in Table 1, where

- W_{HM} = weight of hot metal (lbs)
- W_C = weight of charge (consisting of scrap and hot metal) (lbs)
- W_S = weight of scrap (lbs)
- W_{CaO} = weight of burnt lime (lbs)
- VV = basicity ratio, $\frac{WCaO}{WSiO_2}$ (dimensionless)
- Si = iron silicon content (%)
- Mn = iron manganese content (%)
- T_T = tapping temperature (°F)
- T_M = iron temperature (°F)
- LH = lance height (inches)
- W_{MS} = weight of mill scale (lbs)
- W_F = weight of ore pellets (lbs)
- t_D = delay time between tapping of one heat and the charging of the next (minutes).

Of these quantities, only the weights of scrap, lime and hot metal are dependent. The weights of mill scale and ore, lance height position, basicity ratio and tapping temperature are selected at the discretion of the operators prior to calculation of a furnace charge.

Iron silicon and manganese contents are measured by spectrographic analysis of samples taken during casting operations at the blast furnace. The time required to clean the li[illegible] of the furnace of slag and metal, repair the tap hole, patch the furnace lining, and clean the pit under the furnace is used to determine the delay, t_d.

Iron temperature is recorded by means of a two-color pyrometer sighted on the molten iron being poured from the blast furnace iron mixer car to the iron charging ladle (Fig. 2).

As an added refinement to the mathematical model, expressions were developed for approximating the average temperature and silicon content of a hot metal addition that might consist of a mixture of a drain-out from one mixer ladle and the balance from another that is of different temperature and silicon content.

In order to facilitate computations, a special-purpose slide rule was designed from the mathematical model. With this rule, required scrap additions can be calculated to an accuracy of approximately 1%.

The slide rule was used to perform on-the-spot calculations during a mill trial period (from April 6 to May 9, 1959), on 227 heats. Of the total number of controlled heats, 65.1% were within the desired range at completion of the heat.

Special-Purpose Analog Computer

The mill trials demonstrated that, with a mathematical model of the basic oxygen process, a greater percentage of heats can be turned down within the specified temperature range than is otherwise possible. As a result, it was decided that a special-purpose analog computer should replace the slide rule, the computer being suited for use by operating personnel and also more accurate.

The computer, designed and manufactured by Electronic Associates, is illustrated in Fig. 3. This instrument

permits the melter to solve simultaneously the five basic equations. The computer presents weight of scrap, weight of hot metal, and weight of lime for operator guidance during the charging period of a heat, by a digital voltmeter display. Multiturn potentiometers and Microdials are used for setting the input conditions so the potentiometer settings are directly related to the variables.

The computer is self-contained in a dustproof cabinet of heavy-duty design. Solid-state circuitry and plug-in modular construction are used throughout. Eighteen transistorized operational amplifiers are used in the computer portion of the system. Spare amplifier and panel space was provided to permit the addition of at least four terms to the scrap equations (to accommodate any future changes in steelmaking practice).

The special-purpose computer has the following advantages: (1) Ease of operation. (2) Rapid computation; computations for a typical heat can be completed in approximately 30 seconds. (3) Accuracy; a comparison of digital-computer and analog results demonstrated that the special-purpose computer can solve the given equations to better than $\pm 0.5\%$ (250 lbs of scrap).

Tests on 1300 heats using the computer showed that 67% of the heats were in the acceptable temperature range, compared to 53% without the computer.

This presentation elicited, among others, the following comments:

T. R. Schuerger (U.S. Steel): I had heard that you were purchasing several digital computers. Could you comment on that?

Mr. Simcic: The only application that I know of is the Ramo-Wooldridge computer that is to be applied at the Great Lakes Plant. They (RW) recently set up an arrangement with National Steel to install a digital computer on their basic oxygen furnace. We have no intentions of making use of a digital computer at this time. As you pointed out in your talk, it's very difficult to measure the important variables. In fact, it's impossible to do so during a blow so we are not in a position to justify purchase of a digital computer system which could amount to 10 or 20 times what was spent on this analog system.

W. B. Field (Union Carbide Olefins Co.): Could you give us some assessment of the economics with respect to how much this improvement in holding final temperature really improved the economics of the process?

Mr. Simcic: In this case, our Industrial Engineering Dept. estimated that the computer could be paid off in two or three months by saving time due to less need for correction of the heat by adding scrap or re-blowing. Other factors such as quality are not as easy to pin down, but we feel that there has been an improvement here as well.

Mr. Field: How much attention has the computer required of your personnel in order to keep it operating?

Mr. Simcic: The number of heats that I gave, about one thousand, is somewhat more than one month's operation. We have made about 10,000 computations on the computer and the computer has been fairly reliable. The four-bit logic cards associated with the digital readout gave us some trouble but EAI modified these and that took care of that situation. Then we had a minor problem in the transistorized power supply which has been ironed out.

Mr. Field: You have a requirement for a fairly reliable reference voltage supply since you are dialing in numerical data and you are looking for ½ to 1%. What is the story on your basic reference unit and how stable does it hold its value?

Mr. Simsic: The basic reference is the TR-10 reference unit, and there has been no trouble with short term drift, the most important factor in this area. Our control was supposed to be within 1% but it has actually been in the area of 0.5%.

Frank Cilyo (U.S. Steel): What was the educational and training background of your operators? Were readings taken by your regular operators or by engineering and other highly trained personnel?

Mr. Simcic: After about one week of instruction by the co-author of this paper, **Bill Slatoskey,** the melters had no trouble in going to the computer, setting in their numbers, and making the computation. The main trouble that they had was with the two-color optical pyrometer.

We have the following summary of the third paper, "Simulation of Extremum Adaptive Control System" by **Dr. R. I. Van Nice** (Westinghouse Electric Corp.).

Dr. Robert Van Nice

Van Nice on Adaptive Control

An extremum adaptive control adjusts one or more variables of a system in order to attempt to maintain a performance measure at a maximum (or minimum) value; meanwhile, uncontrolled variables cause a drift in the location of the extremum, and measurements made on the system are contaminated with noise. Chang[1] has described methods of finding the best patterns for extremum adaptation, assuming that one knows statistical properties of the drift and noise, and has a suitable parabolic model for the system performance as a function of the controlled variable(s).

These patterns of adjusting variables, or strategies, are in general quite simple and linear. Calculating the performance level attained by such a control scheme is, however, not easy in the general case. Therefore it is worthwhile to simulate a plant and control system with noise and drift to get results which would be difficult to calculate.

A basic simulation of such a system is being made on an ISI 609 computer, using standard tables of normal deviates for noise and drift.

As with the second paper, we give you practically the complete text of the fourth paper because we found it of interest: "Simulation of Continuous Slab Heating Furnaces" by Dr. A. H. El-Waziri (United States Steel Corp.)

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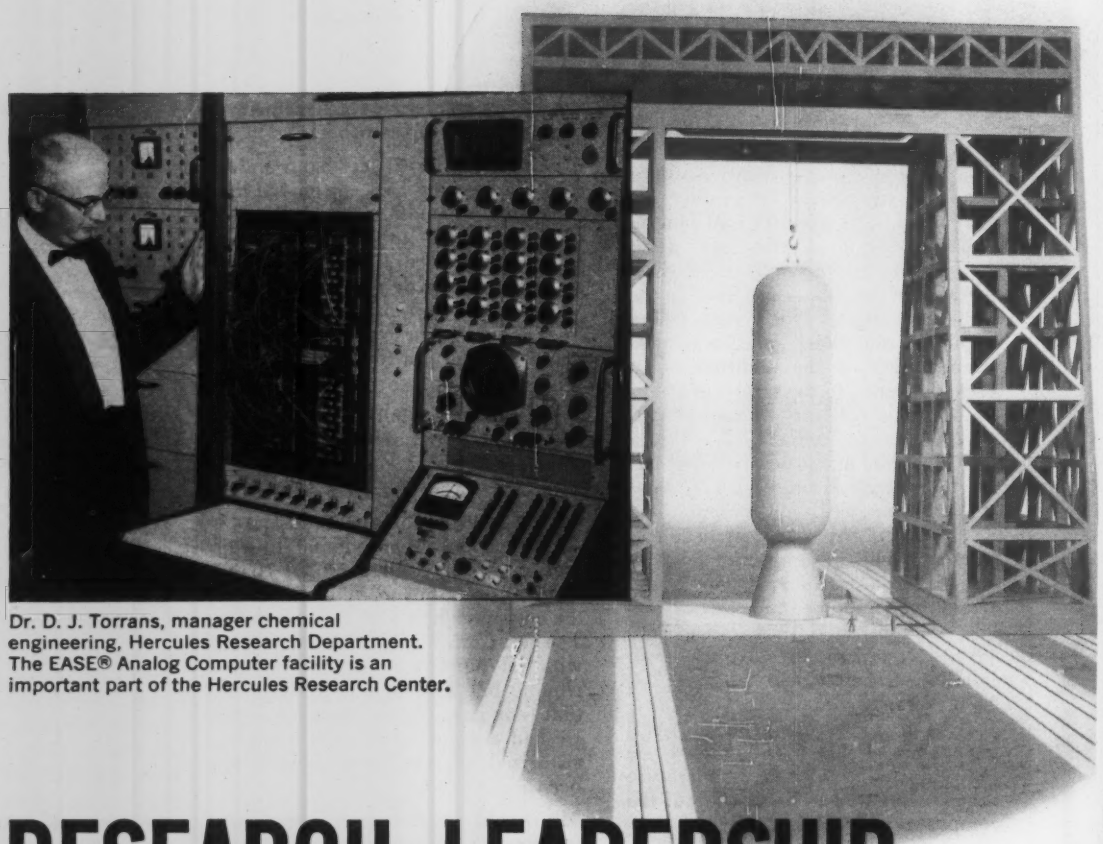
[1] "Optimization of the Adaptive Function by Z-Transform Method," S. S. L. Chang, AIEE Transactions, Vol. 79, Part II, 1960, pp. 223-231.



Dr. D. J. Torrans, manager chemical engineering, Hercules Research Department. The EASE® Analog Computer facility is an important part of the Hercules Research Center.

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CIRCLE 84 ON READER-SERVICE CARD

IN ROLLING of flat products, the steel comes in the form of slabs that have to be heated before rolling. The slabs are heated in a continuous push-type heating furnace. Fig. 1 shows a cross-section of a 3-zone furnace of conventional construction. The slabs are push intermittently into the furnace, one behind the other, to form a steel layer that moves in direction opposite to that of the heating gases. In its passage through the furnace, the steel temperature is raised from room temperature to about 2300°F.

In order to produce a quality product, it is essential to achieve as even a temperature as possible throughout the heated slabs.

As it is difficult and costly to obtain measurements of the temperature distribution throughout the steel while or after heating, a realistic mathematical model that simulates the operation of this type of furnace was developed.

The heating process in the furnace presents a transient two-dimensional problem with boundary conditions which have singularities and are dependent on time. The solution of this problem in closed form is of extreme mathematical complexity. Therefore, the finite difference method was employed to obtain the equations representing the model and correlating the process variables. These equations are suitable for computer calculations.

The idealized mathematical model is constructed of three basic elements:

1. A grid network of nodal points and thermal conductances represents the slabs and the thermal conditions of the cooled slab supports (Fig. 2).

2. An upper heating zone and a lower one. Each of these zones is provided with a radiant heating source at constant temperature. These zones serve to establish the rate of heating of the slabs in the heating zone.

3. A soaking zone where slabs are adiabatically held to equalize their temperature level.

Effect of Skids

The mathematical model has been applied to investigate means for overcoming a problem caused by the presence of water-cooled skids which support the slabs along the heating zone (Fig. 3). The areas of slab surface in contact with the skids and the vicinity are shielded by the skids from direct heating and are also cooled by conduction to the water in the skids. (This water is kept at an average temperature between 100° to 200°F). The contact of the hot slabs with the colder skids results in a large temperature variation within the slabs at the moment when they leave the heating zone and enter the soaking zone. This variation is shown in Fig. 4.

Two methods to reduce the cold spots have been chosen as subjects for laboratory evaluations—(1) raising the temperature of the skid coolant and (2) changing the geometrical configuration of the skids, which has the same effect as moving the location of the cooling point.

A. H. EL-WAZIRI
United States Steel Corporation

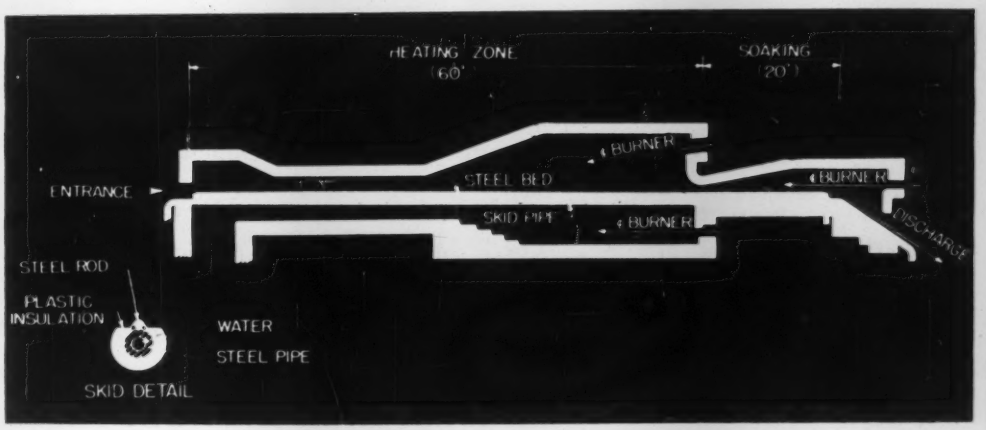

FIG. 1. **THREE-ZONE** slab-heating furnace.

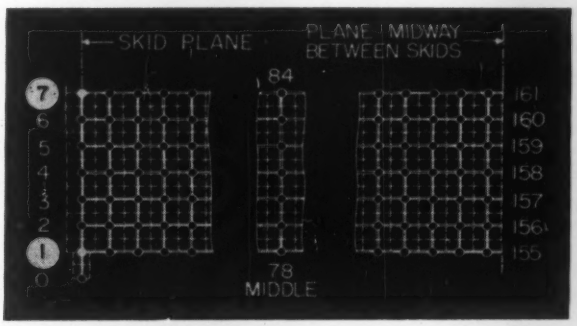

FIG. 2. **SIMULATED SLAB** slice comprises network of 1" squares with nodal points at center. Rectangular element (0 at left) is cooled slab support.

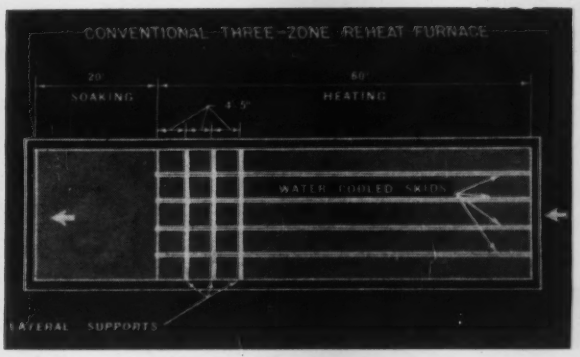

FIG. 3. **WATER-COOLED** skids support slab in heating zone.

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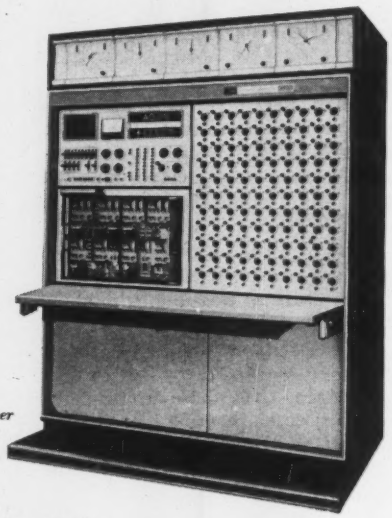

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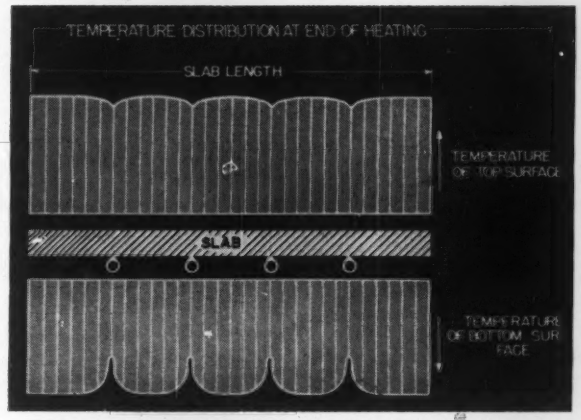
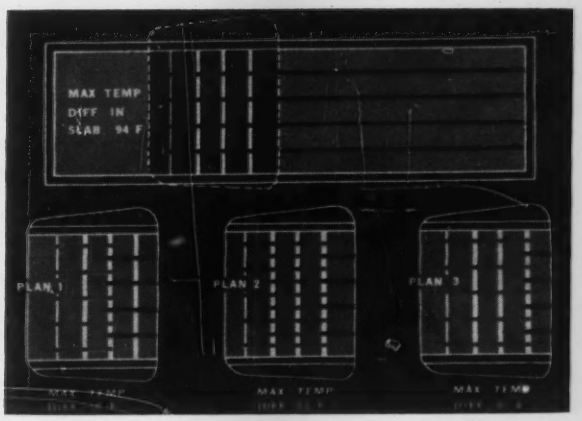


FIG. 4. TEMPERATURE DISTRIBUTION through slab at end of heating zone. Cooled regions are caused by water-cooled skids.

TEMP. OF SKID COOLANT (°F)	MAX TEMP DIFF (°F) BEFORE SOAK	AFTER SOAK	% REDUCTION IN MAX TEMP DIFF
100	720	94	0
300	655	85	10
500	590	75	20
700	525	66	30
900	460	57	40

FIG. 5. SKID-COOLANT temperature effect.



SKID CONFIGURATION	MAX. TEMP. DIFF. (°F)	% REDUCTION IN MAX TEMP DIFF
Conventional	94	0
Plan 1	18	81
Plan 2	23	76
Plan 3	35	63
Plan 4	35	63
Plan 5	41	56
Plan 6	56	40

FIG. 6. VARIOUS skid configurations. Plan 1 was found most effective in reducing temperature variations in slab.

The theoretical results obtained for the effectiveness of raising the *skid coolant temperature* as a means to minimize the skid effect is shown in Fig. 5. The first line of this table shows the mean temperature of the skid-cooling water normally, and the maximum temperature difference in slabs at delivery from the furnace. The rest of the table shows these values for skid-coolant temperature ranging from 300° to 900°F. An improvement up to 40% in the degree of temperature uniformity is possible when using this method. However, raising the coolant temperature is a costly procedure.

Fig. 6 shows the conventional skid construction at top and 3 possible modifications that were investigated. The first plan shown (lower left) was found to be the most effective of six alternative plans investigated. By using this plan, the maximum temperature difference in the slab at exit from the furnace can be reduced, theoretically, from 94° to 18° F (Fig. 6). This is more than 80% improvement in the degree of uniformity. The second plan shown provides a maximum difference of 23°F. The third plan investigated results in a maximum difference of 35°F as indicated.

The mathematical model of this process which has been developed will provide evaluations of other possible approaches, such as changes in heating practice and changes in skid properties, so as to permit an increase in furnace productivity while maintaining uniformity of temperature.

Most of the discussion following this paper concerned details of the particular application, but one we found of particular interest because it emphasizes the fact that computer simulation can be used to investigate possibilities which it would not be practical to investigate by making mechanical changes:

Ed Massell (Electronic Associates Inc., Long Branch, New Jersey): Did you also raise the temperature of the coolant?

Dr. El-Waziri: We tried it in the computer study, but it would not be acceptable in actual practice. You would need steam under pressure, and this would be difficult to accomplish.

This work was presented before AISE in April, 1960 and was published also in *Iron & Steel Engineer*, March, 1961.

We have the following abstract on the fifth and last paper of the meeting: "Study and Simulation of Continuous Processes on a Hybrid Computer" by **K. H. Bhavnani** (Westinghouse Electric Corp.).

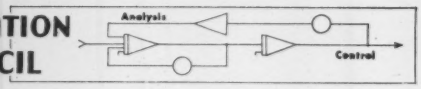
Bhavnani on Hybrid Computers

The study of the dynamic behavior of a process can help in developing an improved control for the process, with resulting economies in the plant operation. A reliable study requires the combined talents of people versed in a number of fields, and experimentation as well as analysis may be necessary to obtain a good model of the process. The model should be simulated on a computer in order to help improve the model itself, to simulate and study possible control schemes, and to demonstrate the results of the study. Analog-computer simulation has been used for some time, but the advent of the digital computer has opened up additional vistas for simulation techniques, especially when a joint or hybrid analog-digital computer system is available.

Specific applications of interest in the study of continuous processes are described in this presentation. One is the simulation of a column for chemical processing in which the material undergoing reaction is retained in the column for a period of time which varies with the production rate. Another is the realization of dynamic

K. H. BHAVNANI

SIMULATION COUNCIL



controller functions on a digital control computer.

Some additional considerations and advantages are also discussed. Though attempts at more exact simulation may lead to a better understanding of the process and better plant design in the future, a very thorough representation is not usually necessary to test the efficiency of the control technique. The simulation of the process and/or the control scheme on a digital computer results in a permanent record on tape or cards with the accompanying convenience and versatility. On the other hand the analog computer can represent the conventional input and output devices, giving a physical feel to the process simulation on the hybrid computer.

This paper brought forth the following comments:

Milt Aronson (Instruments Publishing Co., Pittsburgh, Penna.): What kind of converters did you use with this installation?

Mr. Bhavnani: These are supplied by Information Systems Incorporated and have twelve bits.

Mr. Vernon Larrowe (University of Michigan, Ann Arbor, Mich.): I'm curious about this process of changing analog inputs to digital quantities to compute transfer functions and then going back to analog again. The simulation of transfer functions is one of the things that analog computers do pretty well and it looks like a round-about way of doing it. Then sampling times would not be involved. Why did you do it this way and what is there left for the analog computer to do?

Mr. Bhavnani: The application shown here had the analog computer doing a calculation that could be done in more detail than on the digital computer. The type of application is one where an exact representation of the process is not necessary. The important thing has been to show the feasibility of the control. In a more detailed analysis, you might want to set up the entire process on the analog computer. But enough time and money would have to be available to warrant all of this effort.

As to the first part of the question, the analog computer is the conventional method of control. Perhaps you can use the digital computer to adjust some of the coefficients of the analog controller.

Mr. Schuerger: You were discussing the adaptation of computers to the study of hybrid systems, if I understand you correctly. There is a distinction between using a hybrid system for generating the control function and using a hybrid system for studying the control problem. Are you anticipating using the hybrid system for actual control work?

Mr. Bhavnani: The only one would be the case where you have an analog controller and you would adjust some of its parameters digitally.

Mr. Schuerger: This we are doing at the present where we use a standard controller and adjust the set points.

ROCKY MOUNTAIN S/C MEETING OF 30 SEPT AT BRIGHAM YOUNG UNIVERSITY

When we ask **Maughan Mason** for a summary of the Rocky Mountain Simulation Council activities we really get a *summary*. The following is his account of the technical session in full:

The Council met Saturday, 30 September 1961, at Brigham Young University. Nineteen persons were in attendance.

Speakers were:

A. I. Katz, Director, Training and Education, Electronic Associates, Inc.

I. L. Hebel, Head, Department of Mathematics, Colorado School of Mines

H. R. Warner, M.D., Department of Physiology, L.D.S. Hospital, Salt Lake City, Utah

Katz on Education

Mr. Katz discussed the present usage of computers in the engineering curriculum, and listed other methods for profitable utilization. Some of his suggestions were:

1. Make more effective use of the computer as a demonstration tool in *existing* courses;

2. Show the tediousness of hand calculations compared to computer solution. This can advantageously be done even for analytic solutions;

3. Use the computer selectively, not as a shotgun. Show when to make approximations, demonstrate non-linearities and coupling effects, effects of parameter size and changes, etc.

Mr. Katz also presented the results of a survey of computer courses listed in college catalogs, showing the number of courses listed and those with labs. A graduate level-undergraduate level breakdown was also provided.

Hebel on Computer Uses

Professor Hebel described the computer equipment presently on hand at the School of Mines, as well as some on order. He discussed the philosophy of use, types of problems solved, and methods of funding. Use by *small* groups of students has been stressed.

Extra-curricular seminars and discussion groups have paid handsome dividends in better familiarization of other faculty members; the computer group now forms the nucleus of a research center.

Warner on Medical Uses

Dr. Warner discussed heart and circulation research performed using analog-computer components. Artery transfer functions were initially assumed to be second order; slides displayed forcing function pulses and pulse distortion at various arterial points. Good correspondence was observed between predicted and measured data.

The weak link, according to Dr. Warner, is the magnetic-tape system used to record, erase, re-record, etc. (This despite the fact that a better tape system is not available.)

"ANALOG INTEGRATOR WITH DIGITAL READOUT"

B. C. Van Deusen

Physics-Instrumentation Research Laboratory
Chrysler Corporation
Engineering Division
Detroit 31, Michigan

There are many analog-computer and data-analysis problems where it is desirable to integrate a continuous time dependent signal over a relatively long period of time, and have a numerical readout which is proportional to (or some function of) the total time integral of the function. This paper discusses one method of integrating in this fashion.

The normal analog-computer integrator (See Fig. 1) works on the

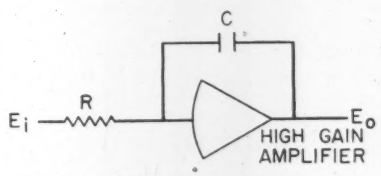


FIG. 1. CONVENTIONAL analog-computer integrator.

principle of charging (and/or discharging) a capacitor in the feedback circuit of a high gain d-c amplifier, at a rate proportional to the input voltage. In this way the voltage across the capacitor, and thus the amplifier output, is proportional to the time integral of the input voltage. This type of integrator is discussed in detail in any basic analog computer text.

The integrator, the backbone of most analog computers, allows computer simulation of dynamic systems. It is normally employed either in negative feedback circuits for anti-drift stability or, for relatively short periods of time (up to several seconds), in positive feedback or "open loop" (no feedback) circuits. If it is desirable to integrate for periods of a minute or more in an open-loop situation, the input signal must be small in order to keep the output within the amplifier operating range. The gain of an integrator is 1/RC, as can be seen from the equation:

$$E_o = -\frac{1}{RC}\int_0^t E_i dt$$

where t is in seconds, R in ohms, C in farads and E_i and E_o in volts.

A real-time integrator with a unity gain (RC = 1) will reach 100 volts in one minute (60 seconds) with an input of 1.67 volts (60 x 1.67 = 100.2v/m). Thus, with the low input levels required for long open-loop integrations, drift errors can amount to a significant percentage of the output.

In order to integrate accurately over a long period of time, the intrinsic drift must be minimized, and the dynamic range of the integrator must be increased to allow larger input voltages. One method of accomplishing the latter is to allow the integrator to reach a certain level, reset to zero, and continue integrating. If the level reached is the signal to reset and not a predesignated time (as in a repetitive operation) then the number of cycles will be proportional to the total integral. A method for doing this is discussed.

The purpose for developing the circuit was to measure the hydrocarbon weight in automotive engine exhaust systems over a 20-minute test period. Transducers mounted on the vehicle measured mole percent hydrocarbon and exhaust flow rate. This information was relayed to the analog computer by an F-M telemetry link. At the computer the signals were multiplied to give the instantaneous weight per unit time of hydrocarbon in the exhaust system. The integral over the 20-minute test period then gave the total hydrocarbon weight for the test period.

Circuit

The Integrator (Fig. 2) is comprised of three operational amplifiers.

Amplifier 3 has a + 100-volt output for a negative input and a —100-volt output for a positive input. Initially this output is + 100 volts due to the initial conditions on amplifier 1. In this state it does not affect amplifier 1 because of the diode direction, but does give an input to amplifier 2. Amplifier 1, which is a normal integrator, then integrates the input signal starting at the initial conditions of + 100-volt output.

The output decreases with time until it reaches —100 volts, at which point the output of amplifier 2 goes positive. This causes amplifier 3 to switch to —100 volts output, which gives a high-gain input to amplifier 1, causing it to reset rapidly and continue integration.

The diode and battery in the feedback loop of amplifier 1 assure that the reset is to exactly + 100 volts. Amplifier 1 would reset to a higher value without this feedback limitation due to the extremely high gain and limited frequency response of the other amplifiers.

A plot of the amplifier outputs *versus* time is shown in Fig. 3. Note that amplifier 3 has large spikes at each reset time. These spikes can be counted by an electronic counter to give a number proportional to the integral of the input signal over a predesignated time.

The reset time depends on the forward resistance of the diode in the input circuit of amplifier 1. It was measured at 6 milliseconds in this particular application. The time for one count is then (200/X) + 0.006 seconds, where X is the average input signal to be integrated, in volts. The number of counts per minute is then 60 sec/min divided by (200/X) + 0.006 sec, or

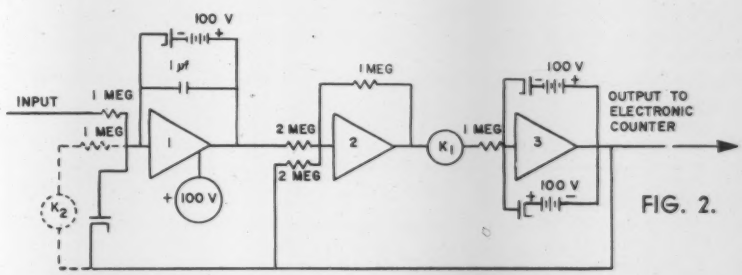


FIG. 2.

$$\frac{60\ X}{200 + 0.006} = 0.3X$$

This integrator uses the full 200-volt dynamic range of the amplifiers and will integrate any input voltage with a positive average. If the input is small the gain can be changed. If it has a negative average, the input diode to amplifier 1 can be inverted along with the feedback battery and diode, and the initial conditions changed to −100 volts. If the input average can be either positive or negative, it is desirable to add a voltage to it to assure that it is always positive. This can be done with the potentiometer K_2 (dashed lines in Fig. 2) and the count rate is then $0.3\ (X + 100K_2)$ counts per minute. Potentiometer K_1 is a fairly small setting and is adjusted to assure stability of the positive feedback loop of amplifiers 2 and 3.

SCI Activities

Announcements Received

Eastern Simulation Council

13 November 1961; At Electronic Associates Inc., Princeton Computation Center, Princeton, New Jersey; "Human Factors in Analog Computation".

A discussion of factors related to the man in analog computation, his introduction to the subject, his education and training, his desirable talents, his position and mission in the organization. Members of a panel will present views of these topics from different sections of industry before opening the subject for general discussion.

PANEL MEMBERS:

The University—Dr. D. Lamb, (University of Delaware)
The large installation—Ed King, (G. E., Philadelphia)
The small installation—V. Backanowski, (DuPont of Canada)
The process industry—R. Franks, (DuPont)
Government—J. Milsum, (NCR, Canada)
Computer manufacturer—A. I. Katz, (EAI)
Chairman—A. E. Rogers, (EAI)

Western Simulation Council

18 January 1961; Hosts: General Atomic Division, General Dynamics Corporation and Control Systems Division of Daystrom; La Jolla, California.

Tentative program:
"Simulation of a Central Station Power Plant" (Daystrom)
"Simulation of the Peach Bottom Atomic Power Plant" (General Atomic)
"Unusual Applications of DYSTAC" (Computer Systems Inc.)
Paper from Convair

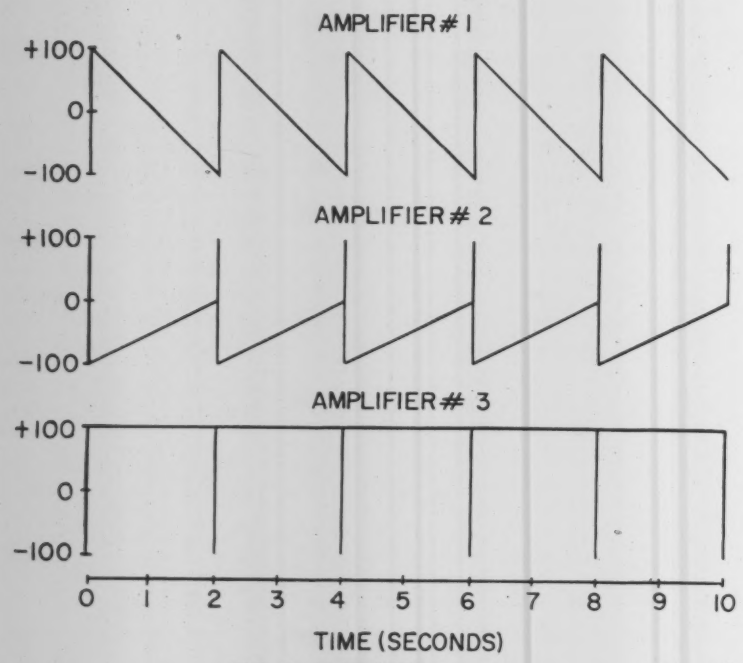


FIG. 3. AMPLIFIER outputs

There will be a tour of the General Atomic Laboratories, including TRIGA reactor facility, with high power excursion demonstrations; Hot cell with a demonstration of remote handling equipment; Experimental building, including a flow model of the Peach Bottom Reactor; and a tour of Daystrom Control Systems Division Laboratory, showing manufacture of process control digital computers and demonstrations of unusual DYSTAC solutions to engineering problems on Daystrom's C.S.I. analog computers.

Reports Received

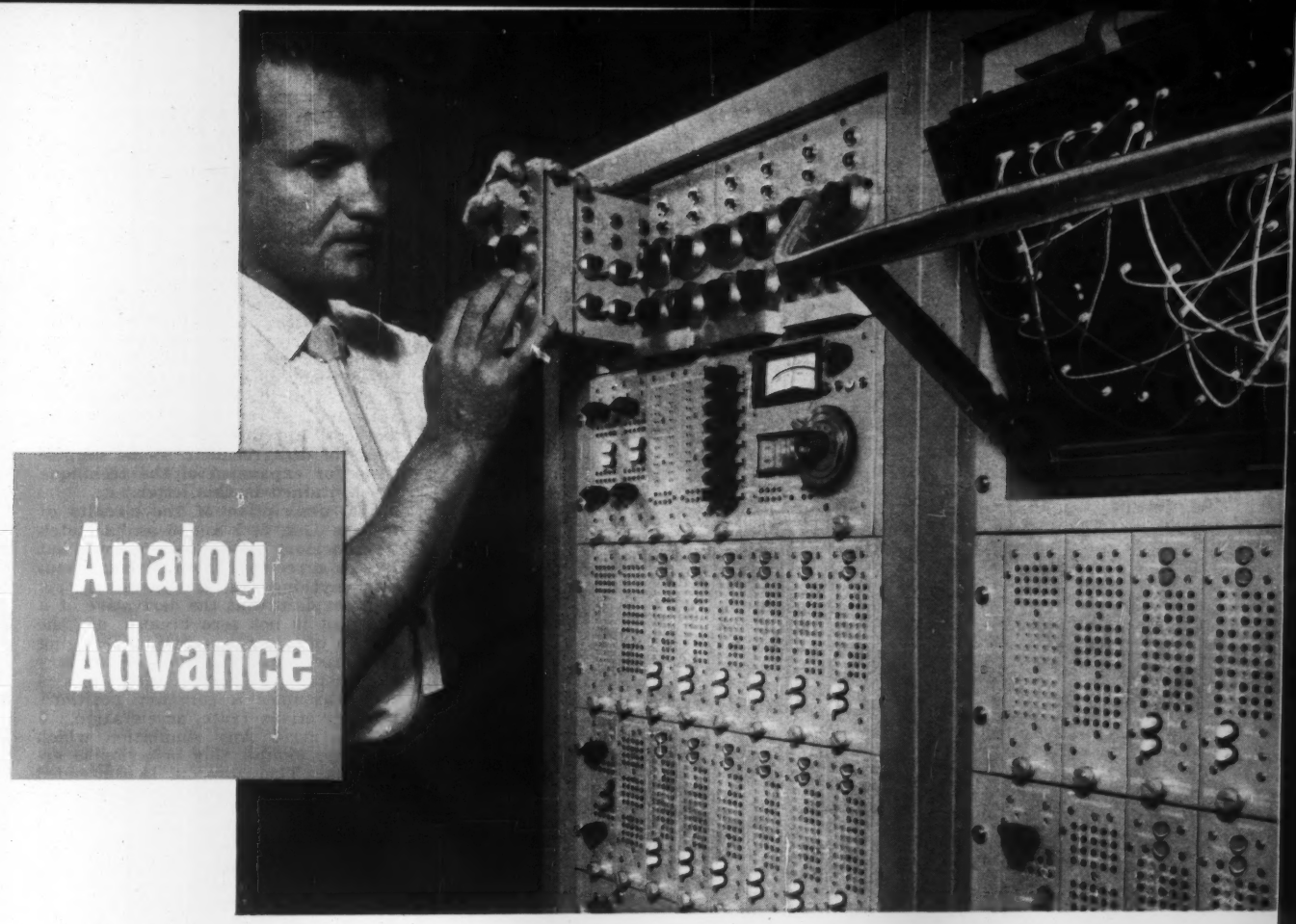
Southeastern Simulation Council

From **Jim Tootle**, Secretary of the Southeastern SC, we have received the minutes of a meeting held in Orlando, Florida on 20 October 1961, for which the Martin Company was host. Jim also enclosed a condensation of "some comments on digital differential analyzers as expansion equipment for the general-purpose analog computer" by **T. D. Truitt** (Director of the Advanced Study Group, Research and Computation Division, Electronic Associates Inc., Princeton, New Jersey), which we will publish in the near future, hopefully with some information on the other three talks given.

Information Without Theory

Because of the increased interest in the simulation of biological systems, and in information processing by the medical profession, the Executive Committee of your Board of Directors is considering SCI co-sponsorship of the Second Annual San Diego Symposium on Biomedical Engineering, to be held in San Diego, 19-21 June, 1962. If any readers are interested in this area they should watch the *Newsletter* for further info, or write your Ed for details.

Simulation Councils Inc. is considering reprinting the Simulation Council *Newsletters* which appeared monthly in mimeographed form from November 1952 through February 1955 (at which time the *Newsletter* moved into *Instruments and Control Systems*). If we do decide to go ahead and republish these back issues—it will depend on how much interest is shown—they will be reproduced by the ozalid process and bound into a 225-page book, which will sell for $10 a copy. Orders should be addressed to your Ed. at 8484 La Jolla Shores Drive, La Jolla, Calif.



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The user can start with as few as 10 amplifiers and expand to 60 as necessary. Two or more 60 amplifier computers can be slaved to solve more complex problems. This flexibility is the product of a new packaging concept which emphasizes modularity and etched wiring. The plethora of cables usually associated with computers is gone but hardly grieved. Note these other unique features and specifications.

• **NEW AMPLIFIER** Bandwidth, 1 mc; drift, 20 microvolts per day; gain, 10^8; noise, 500 microvolts; output, ±100 volts @ 20 milliamps. Three types of dual amplifiers are available—integrators, summers and inverters.

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• **NEW POTENTIOMETER MODULE** Each compact module contains 20 fused precision potentiometers mounted on the smoothest drawer slides we've ever found. Eighty potentiometers take only 7" of panel height.

• **NEW CONTROL CENTER** Pushbuttons select these modes of operation: compute, hold, reset, automatic recycle, slave, audible overload indication, and automatic hold. A new reference potentiometer allows null voltage measurements accurate to 0.02%. Meter sensitivities which can be pushbutton chosen are 300, 100, 30, 10, 3 volts, zero centered.

Forward and reverse relay logic is incorporated for either iterative or continuous operation.

OTHER FEATURES The novel amplifier construction incorporates a built-in jack field on every module which helps the user get a quality computer for minimum cost and later, when he adds the standard removable patch board, he can use the amplifier patching bay as a built-in simulation board. Several sizes of removable patch boards are available both shielded and unshielded. All critical computing components are mounted in a temperature controlled environment.

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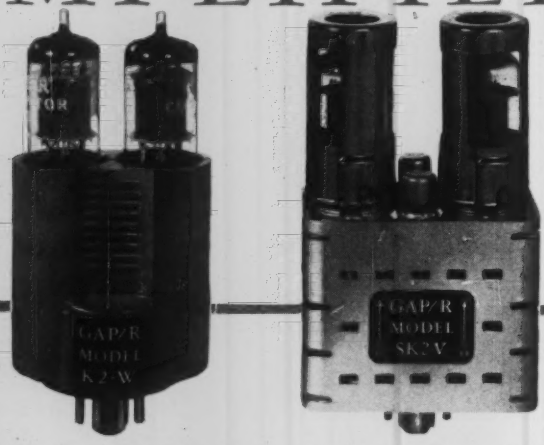

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Open Loop DC Gain	15,000	30,000	1000	100,000	+3.5	2000
Output	±50v 1ma	±100v 3ma	—	±100v 3ma	±100v 20ma	—
Unity Gain Crossover	400 KCPS	500 KCPS	—	1 MCPS	—	—
Unit price*	$22	$27	$52	$58	$36	$65

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LETTERS

J. E. Sherman, Chairman of the Board
Simulation Councils, Incorporated
Box 504
Sunnyvale, California

Dear Mr. Sherman:

The problem of simulating second order systems so that the limits could have realistic physical interpretation and the derivatives could be valid was studied by me and reported in a Convair report dated 5 December, 1957. A review of Mr. Anderson's paper of May 1961 shows some similarity of methods and interpretation but also areas of disagreement. Some suggestions for expansion of the technique are contained in this letter.

The description of the circuits of figures 1, 2, 3, 5 and 6 as "a clutch with memory" is accurate enough but I can't agree that these circuits simulate anything that is useful.

To explain that the derivative of a constant is not zero because of "the inertia of a servo motor in changing the direction of rotation" is not very satisfactory. When a servo hits a stop (assumes a constant position) all derivatives (rate, acceleration, . .) become zero. Any simulation which does not exhibit this behavior is erroneous. Therefore, it is contended that Figures 4, 7 and 8 in the subject paper are useful because they meet this requirement. Figures 1, 2, 3, 5 and 6 require a "clutch with memory" to give them physical meaning and are of no practical importance.

Mr. Anderson showed no resistors in series with the diodes in his circuits. In the work done here diode currents fed back around three amplifiers caused violent instability. The computer was manufactured by one of the better known companies but it may be that other d-c amplifiers than these would behave differently. Anyway, a series resistance is useful in that it can be scaled to match the behavior of the limit. A large resistance simulates a compliant limit.

Acceleration could be limited as well as rate and position. This has the useful physical interpretation of torque saturation.

Position, velocity and torque limits have been simulated here in studies of servos with transfer functions of orders higher than second.

G. E. Wentworth
Sr. Aerosystems Engineer
GENERAL DYNAMICS/
FORT WORTH
Mail Zone E30

Mr. John McLeod
8484 *La Jolla Shores Drive*
La Jolla, California

Dear Mr. McLeod

Enclosed is a letter from G. E. Wentworth of Convair, Fort Worth commenting on the first article of the Techniques Column.

I feel that his points on series resistances and acceleration limits are well taken since it is our practice to use a buffer resistor between the summing junction and the actual grid termination when necessary for the purposes of stability. However, I think he has misinterpreted the clutch

situation in Figures 2, 3, 5 and 6. These are not memory clutches, but simple friction clutches which are sometimes included in electro-mechanical systems to protect the driving mechanism when the limits of physical travel are attained. The rates which are not zero when the limit is attained refer to components on the driving side of the clutch.

T. C. Anderson
Analog Computing
Lockheed Aircraft Corporation
Sunnyvale, California

Mr. John McLeod
Dear John:

In recent months people in the field of analog simulation have begun to take a look at where their field is headed. Basically, the questions group about the following topics:

1. Why are digital computers being used to do jobs analog computers can do better? Can this trend be expected to continue?
2. What can the designers, manufacturers, and vendors of analog equipment do to influence the trend?
3. What part can the user be expected to play?

It is apparent that money is a big factor, in fact the biggest factor—a ratio of 150 to 1 in company capitalizations and sales. Analog companies hardly have the David and Goliath approach; they are simply in the noise level. Another factor which is important, but which the analog manufacturers will not admit, is that nothing new has been offered in analog equipment since the changeover from the mechanical to the electronic differential analyzer. Certainly there have been improvements, but no innovations that give benefits of a magnitude or better. Perhaps it is a case of "How much more accurate can a resistor be made?"

The public image of analog computation is non-existent...

As to the user, one thing that can definitely be done is to break up the tight loop of introverts who have established an excellent lore in the analog computation field, but have not communicated this lore to the scientific and engineering community. To a certain extent this is being attacked by the concerted effort of a few to get publications and articles to the public.... In the process control areas, even though analog method got there first, the digital methods have pre-empted them.

So far I have compared analog progress to digital, and *this is a trap to get out of.* It isn't a matter of comparison at all, but a matter of individualism. The first step in asserting this individual character is to stop calling the electronic differential analyzer an "analog computer." Instead it is suggested that we go back to the meaning of the word analog and call it a *simulator!* In conversations with the boss, the customer, the visitor, the wife, emphasize the difference!... Liken the analog simulator to the "feminine" because it is subtle and requires individual care and understanding. Make digital the masculine, emphasizing conformity, brute force, and unsubtleness.

What can the manufacturers do? For one thing, there are areas for future development which are going begging for want of analog techniques. The literature and the conferences have been filled with papers about "intelligent machines." Bionics is a new term coined to describe the marriage of biology and electronics. Most of the work in this realm is the attempt to *simulate* biological functions electronically. Even by virtue of the names chosen for the activity, a path is provided for exploitation both in use of simulation techniques and for the generation of a public image.

Heuristically is the way that the analog device simulates. Much of the lore of intelligent machine study is based on heuristic methods. It would appear, therefore, that the analog approach is the right approach.

The analog manufacturers are at fault for either ignoring or not being aware of this entirely new field and taking advantage of it...

To sum up, analog simulation is in the doldrums, and will not get out unless some transient starts a logical chain of events. This chain of events should include: (a) A new attitude; (b) A new public image; (c) A new field of exploitation.

Bob Horwitz, Head,
Analog Computers
General Dynamics/
Astronautics, San Diego

(From a circular letter from **David R. Miller,** President of Comcor, Inc., 5310 E. Pacific Place, Denver 22, Colorado)

" . . . Many people believe the analog computer industry has reached its zenith, and I am repeatedly asked why Comcor, Inc. has entered a field that is admittedly competitive and presumed to be in decline. The answer is simple. I do not consider the analog industry in decline, but rather static from the lack of new ideas and equipment. Analogous computation is as old as man, and the assumption that electronic analog computers in two decades have fully plumbed and exploited this principle is totally unwarranted....

Comcor, Inc. has a dual function in the analog industry; equipment modernization, and advanced product development. Most operational analog computers do not reflect current levels of analog technology, and can be revitalized with new components, logic, programming and readout equipment.

Dear John:

I have noted with interest the debate on the future of analog computation which seems to pit those who say "the analog computer field is dying" against those who say that "analog computers will always have some small part of the vast computing field which the digital computer will always enjoy."

I feel that both views are unrealistic because:

1. The analog computer *is* the *basic* system analyzer and synthesizer; it can only die when these terms have no meaning.
2. The digital computer is financed by the tens of millions of dollars that result from sales of smaller digital equipments ranging from electric typewriters to card sorters. If digital computers used in scientific and industrial work had to support themselves (as analog computers must) the relative size of the two fields would be entirely different.

I fail to be impressed by uneconomic giants; I continue to be impressed by the power of the analog computer in teaching and using the language of science and engineering—mathematics.

The analog computer field, like any field, can use greater publicity, even though 45,000 scientific and industrial workers read the Simulation Council Newsletter every month (I have much evidence that this portion of INTRUMENTS AND CONTROL SYSTEMS is one of the most widely read sections). To help even further in this regard, can we add a section on "Industrial and Educational Uses of Analog Computer" to the S/C N/L, and point out every month where and how analog computers are being used in industry and in education, applications usually with beautiful results without vast expenditures?

Milt Aronson

Next time you calculate my income tax, don't leave it in binary numbers!

Low Cost Cubic S-70 Data System Reads 100 Channels/Minute

Because of the high operating speed of the reed relays (used in the digital voltmeter) the new Cubic S-70 Data System gives readings 6 times faster than any others using stepping switch voltmeters. The Cubic S-70 monitors up to 100 separate channels, provides instantaneous large digital readout on the voltmeter, and prints out a permanent record on paper tape of 100 readings a minute. Yet it costs only $4650, a fraction of the cost of most data systems now in use. Price includes the Cubic V-70 Reed Relay Digital Voltmeter, the Cubic Scanner to rapidly sample 100 channels, and an 11-column printer. An ac-dc converter or a pre-amplifier may be added at slight additional cost. The reed relays in the voltmeter assure you of at least a decade of flawless service without periodic maintenance. This is a simple, pre-packaged, standard system made up of production modules. You simply plug it in and start recording data. For more details on the S-70 Data System, write to Department IC-111

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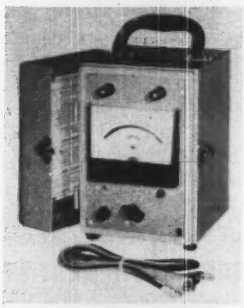
PORTABLE OHMMETER



New portable Ohmmeters feature accuracy to ½ of 1%. Model 244-A has four ranges, allowing direct reading measurements from 0.05 ohm to 50,000 ohms, with a center-scale value of 1.2 ohms on low range. Model 246-A provides measurement from 0.1 ohm to 100,000 ohms.—*Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.*

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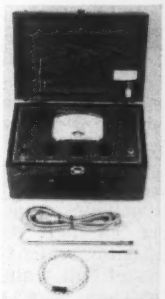

New Flowtronic 55 permits direct accurate reading of surface temperature in range of 20° to 220°F and air velocity in ranges of 0-1000 fpm, 1000-2000 fpm, and 2000-4000 fpm. Has rapid response electrical output (d-c to 1000 cps) suitable for use with chart recorder. Temperature scale is linear over entire 20°-to-220°F range; velocity scale is linear at high velocities.—*Flow Corp., 11 Carleton St., Cambridge 42, Mass.*

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New self-contained Power-O-Matic 60 Saturable Reactor operates without contacts, switches, moving parts, potentiometer sliders, photo cells, etc., has straight-line temperature characteristics stepless, switchless, infinitely proportional wattage control. Sizes: 2 to 10 kva. Reactor package can be used as conversion kit for equipment with conventional On-OFF cycling control systems.—*Blue M Electric Co., 138 & Chatham St., Blue Island, Ill.*

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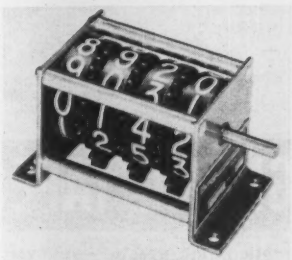

New Model 3522 reversible Counter has digits 27/64" high on molded-nylon drums of $1\frac{7}{16}$" dia. Package is $1\frac{11}{16}$" wide x 2" high x $3\frac{3}{16}$" long.—*Haydon Instrument Co., 17 Brown St., Waterbury 20, Conn.*

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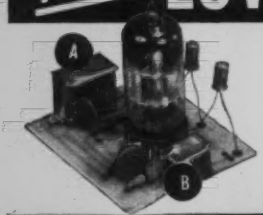

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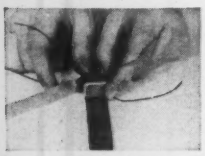
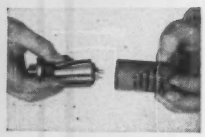

Wraps easily.


Inserts readily to convert existing non-shielding enclosures.

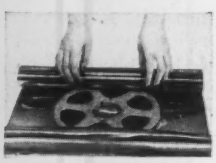
Shielding cables reduces magnetic radiation or pickup.

Wrapping tubes prevents outside magnetic interference.

PROTECT VITAL MAGNETIC TAPES

When accidentally exposed to unpredictable magnetic fields, presto!—your valuable data is combined with confusing signals or even erased.

For complete, distortion-free protection of valuable magnetic tapes during transportation or storage. Single or multiple reel Rigid Netic Enclosures available in many convenient sizes and shapes.


Thin pliable foil wraps easily around magnetic tape, maintaining original recorded fidelity.

Rigid Netic (.014" and up in thickness) Shielded Rooms and Enclosures for safe, distortion-free storage of large quantities of recorded magnetic tapes.

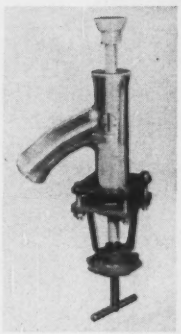
Composite photo to demonstrating that magnetic shielding qualities of Rigid Netic Alloy Material are not significantly affected by vibration, shock (including dropping or bumping) etc. Netic is non-retentive, requires no periodic annealing.

Write for further details today.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue, Chicago 22, Illinois
ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

CIRCLE 92 ON READER-SERVICE CARD

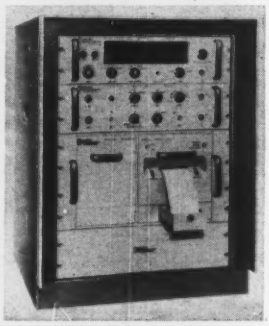
DRAIN VALVES



New line of Flush Bottom Drain Valves combines Pyrex glass and Teflon construction for complete corrosion resistance to all chemical process fluids except hydrofluoric acid and hot concentrated caustics. Available in 1½" and 2" sizes.—*Chem Flow Corp.*, 117 *Paterson Ave., Little Falls, N. J.*

CIRCLE 222 ON READER-SERVICE CARD

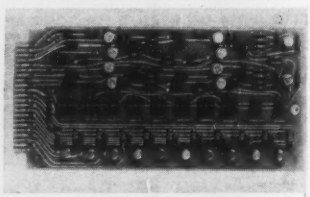
CAPACITOR TESTING



New Model 10003 Capacitance Monitoring System combines the EI Model 6150 capacitance-and-dissipation-factor-to-dc converter with a digital printer to provide a low priced automatic capacitance measuring system. Specifications of Model 6150 Capacity Meter, the heart of the 10003 system, include: test frequencies—120 and 1000 cps; capacitance range—0.01 $\mu\mu$fd to 1000 μfd; capacitance accuracy—0.1% of reading ±1 digit referred to standard capacitor; capacitance resolution—0.01% of full scale, speed of measurement—less than 1 sec per parameter.—*Electro Instruments, Inc.*, 8611 *Balboa Ave., San Diego* 11, *Calif.*

CIRCLE 223 ON READER-SERVICE CARD

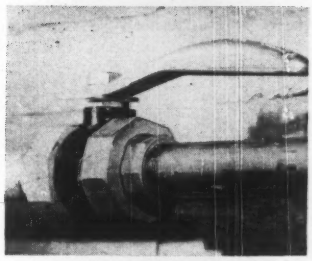
COUNTER/INDICATOR



New Model (D9) G-104/N-1A Set/Reset Indicator plug-in module in line of counters and counter/indicators has 4½" x 9" single-board configuration. Includes diode matrix expressly for applications involving parallel transfer of information in the 1-2-3-8 code into a remote Nixie digital display at frequencies up to 100 kc.—*Electronic Control Products, U. S. Rt.* 22, *Box* 286, *Dunellen, N. J.*

CIRCLE 224 ON READER-SERVICE CARD

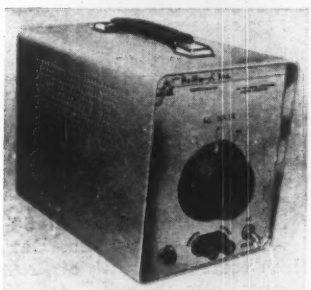
BALL VALVE



New Petro Ball Valve is now made with a nylon seat to give it a choice of Teflon, Neoprene, Buna-N and nylon. Nylon seat is rated at 2,500 psi for ¼" through ¾" sizes, and 2,000 psi for 1" through 2" valves. Effective operational range is —20° to 180°F.—*Clayton Mark & Co., Forged Steel Products Div., 1900 Dempster St., Evanston, Ill.*

CIRCLE 225 ON READER-SERVICE CARD

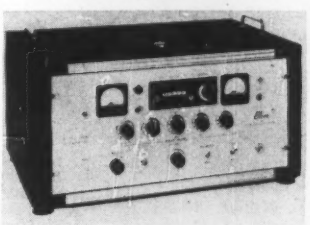
A-C VOLTAGE STANDARD



New Model DFVS-101 solid-state portable A-c Standard provides precise accuracy and stability characteristics. Bulletins.—*Delta-f, Inc., 113 E. State St., Geneva, Ill.*

CIRCLE 226 ON READER-SERVICE CARD

INTEGRATOR

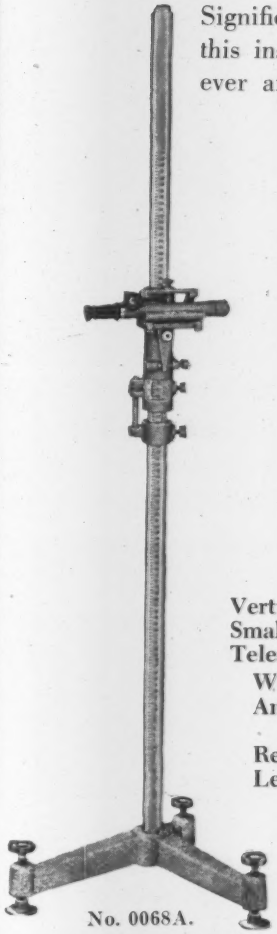


New Model J101A Integrator is an analog accumulator which integrates amplified signals derived from transducing elements that measure radiation, temperature, displacement, moisture, humidity, light, color, strain, weight, absorption, etc. Can be used with current and voltage indicators, recorders, or other instrumentation that supplies full-scale output of one ma at a voltage between 10 to 100 v. —*Elcor Inc., Subs. of Welex Electronics Corps., 1125 W. Broad St., Falls Church, Va.*

CIRCLE 227 ON READER-SERVICE CARD

Welch Improved CATHETOMETER

Significant recent engineering improvements in this instrument insure better performance than ever and more years of satisfactory service.



No. 0068A.

This cathetometer is designed for precise measurement of vertical distances through a range of 100 cm.

It is particularly useful where the object to be observed is not conveniently accessible, or may easily be disturbed by physical contact, or must be located in a position too hazardous to permit the observer to be in close proximity.

It is also commonly employed for qualitative telescopic viewing within the laboratory because of its versatile positioning adjustments and over-all stability.

Vertical Range ..... **100 cm**
Smallest Reading by Vernier ..... **0.05 mm**
Telescope
Working Distance ..... **45 cm to Infinity**
Angular Magnification ..... **12 × at 45 cm**
..... **8 × at Infinity**
Reticle ..... **90-degree crosshairs**
Level Sensitivity ..... **50 Seconds**

Cat. No. 0068A.....Each $257.50

Write for illustrated circular describing the many excellent features of this instrument.

THE WELCH SCIENTIFIC COMPANY
ESTABLISHED 1880
1515 Sedgwick Street, Dept. B, Chicago 10, Illinois, U.S.A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

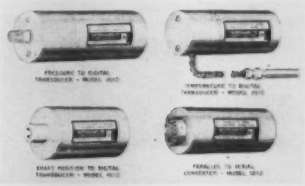
CIRCLE 93 ON READER-SERVICE CARD

HI VAC T/C CONTROLLER

New solid-state TC-9 High Vacuum Thermocouple Controller is a dual control unit for vacuum systems, has no contacts. Response time is less than ½ sec. Adjustable over vacuum 1 atm to 1 μ. Requires 25 watt.—*Vacuum Electronics Corp., Terminal Dr., Plainview, N. Y.*

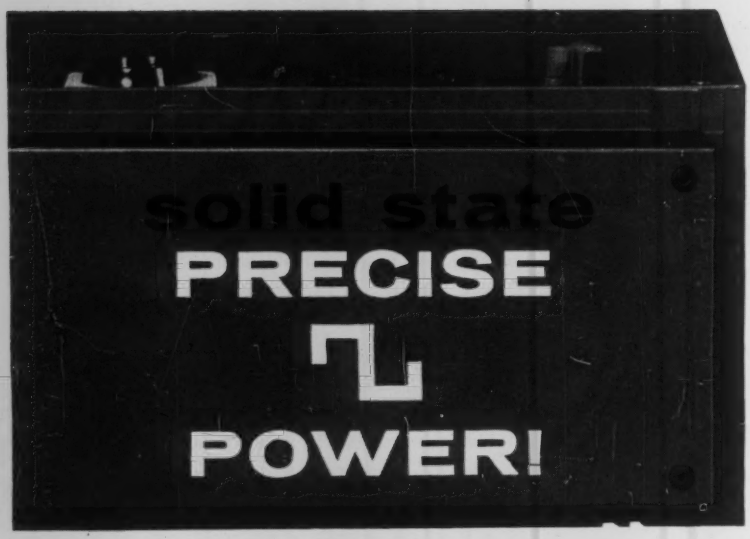
CIRCLE 228 ON READER-SERVICE CARD

DIGITAL TRANSDUCERS



New Digital Transducers transmit digital information to central multiplexer which in turn relays addressed information to controller or data recorder. Result: increased reliability. —*Diginamics Corp., 2525 E. Franklin Ave., Minneapolis 6. Minn.*

CIRCLE 229 ON READER-SERVICE CARD



RISE AND FALL TIME—250 NANOSECONDS!

SYMMETRY—500 NANOSECONDS!

Now—ELIN'S fully-transistorized square wave power unit, model SQP106T, gives you the new dimension of precision you need, can depend on, for missile systems checkout, gyro and synchro testing, etc. Enjoy having ELIN performance superiority, versatility, compact size—working for you soon!

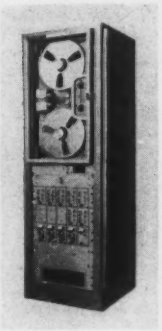
ELIN
Model
SQP106T

WRITE TODAY FOR COMPLETE ELIN SOLID STATE DATA FILE!

elin DIVISION
International Electronic Research Corporation
135 West Magnolia Boulevard, Burbank, California

CIRCLE 94 ON READER-SERVICE CARD

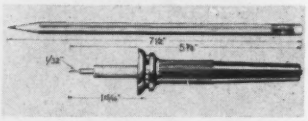
MAGNETIC TAPE SYSTEM



New LAR 7400 Analog Magnetic Tape System with solid-state FM section for data handling in connection with telemetry applications, jet and rocket engine tests, environmental vibration, wind tunnel analysis, etc., records 20-kc FM data at 40% carrier frequency deviation with 40 kc optional at 20% deviation. When arranged for direct record, it accepts either 100 kc at 60 ips in standard or 30 ips in extended mode. Upper frequency limits are proportionately reduced at lower tape speeds with 100 cps representing the lowest acceptable frequency in one-step recording.—*Minneapolis-Honeywell, Industrial Systems Div.*, 10721 *Hanna St., Beltsville, Md.*

CIRCLE 230 ON READER-SERVICE CARD

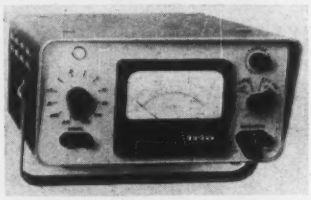
SOLDERING IRON



New Soldering Iron features 5⅞" overall length, 1/32" tip dia, Durotherm iron coated tips with different point shapes, also with 1/16" and ⅛" dia. Uses 12 watts; melts solder in less than 1 minute, reaches working temperature (550°F) in less than 2 minutes, and 700°F in less than 3 minutes.—*Hexacon Electric Co.*, 295 *W. Clay Ave., Roselle Park, N. J.*

CIRCLE 231 ON READER-SERVICE CARD

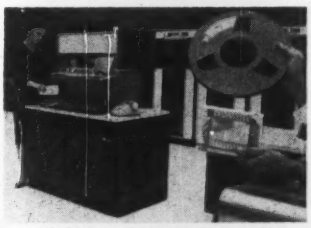
PHASE-DISCRIMINATING VTVM



New Model 131-1 floating-signal Vacuum Tube Voltmeter provides a "normal" and a "phase-discriminating" mode. Specifications include full-scale sensitivity of twelve ranges (with 1:3:10 overlap) from 0.001 to 300 v rms; input impedance of 10 megohms min; rated frequency range of (normal) 5 cps—200 kc; (phase sen.) 50-5000 cps, accuracy of (normal mode) ±2% of full scale from 10 to 100,000 cps, ±3% from 5-10 cps and 100 kc; ±5% from 150-200 kc; (phase-discriminating): ±2% of full scale.—*Trio Labs., Inc., Dupont St., Plainview, L. I., N. Y.*

CIRCLE 232 ON READER-SERVICE CARD

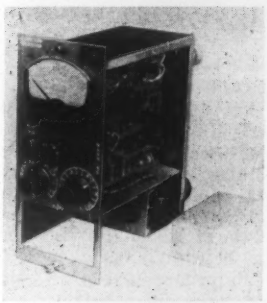
TELE-PROCESSING UNITS



New fully-compatible solid-state Tele-processing units send or receive business or scientific data over leased communications lines at up to 300 characters/sec. Data transmitted from punched cards, for example, can be received in cards, on tape or in a computer's memory. Units are: IBM 7702 Magnetic-tape Transmission Terminal, which handles information recorded on tape; and IBM 1013 Card-transmission Terminal, for higher punched card communication speeds.—*International Business Machines Corp., Data Processing Div., 112 E. Post Rd., White Plains, N. Y.*

CIRCLE 233 ON READER-SERVICE CARD

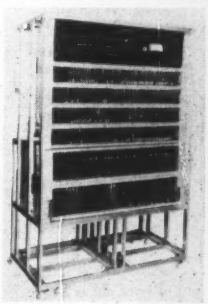
VIBRATION MONITOR



New transistorized modular portable Vibration Monitor has frequency range of 10 to 1,000 cps and displacement range of 1.5, 5 and 15 mils. Adaptable to 110-v or battery power. —*Leheigh Valley Electronics, Inc., 215 S. 3rd, Allentown, Pa.*

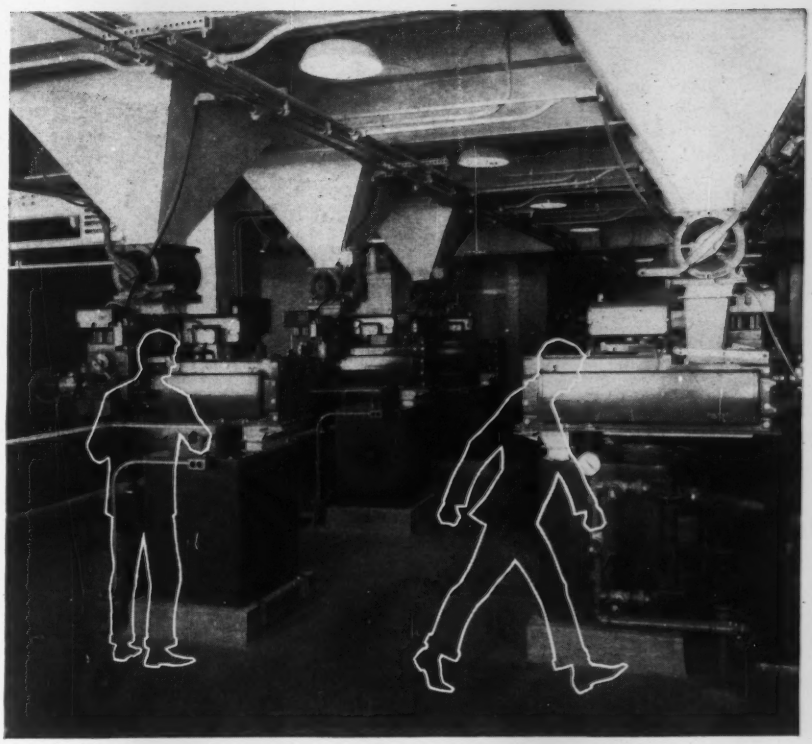
CIRCLE 234 ON READER-SERVICE CARD

RANDOM ACCESS MEMORY



New Type LQ large-capacity ferrite-core random-access Memory has a rate of 667 kc (1.5 μsec) for a complete read-restore or write-clear cycle. Memory modules use linear or word-select drive system, operate in three modes: read-restore, clear-write, and split read and write. Word lengths are up to 56 bits. Memory is compatible with all current computer logics.—*Ampex Computer Products Co., Box 329, Culver City, Calif.*

CIRCLE 235 ON READER-SERVICE CARD



SET IT...FORGET IT...

THE W&T MERCHEN FEEDER

When your dry blending or batching process calls for accuracy hour after hour, you need Merchen Feeders. Wallace & Tiernan Merchens feed like clockwork without attention . . . never waver in even the most exacting use.

Their 0.1% sensitivity means that a change as small as 1 ounce in a 63-pound belt load automatically corrects the feed gate setting. You get continuous delivery at set feed rate. And you get true gravimetric feeding. Merchens are never affected by density changes. They self-adjust. You select the feed rate; the Merchen does the rest.

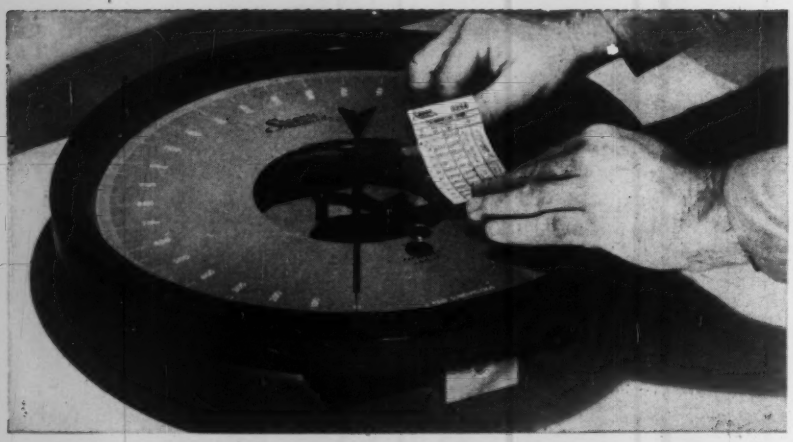
And Merchens give you the other qualities you look for in a feeder: minute-to-minute accuracy within ±1%, rigid, vibration-free construction, compact size, versatility. With Merchens you can control other dry or liquid feeders with pneumatic signals. Or you can use Merchens as slaves, responding to master signals.

For more information, write Dept. M-56.48.

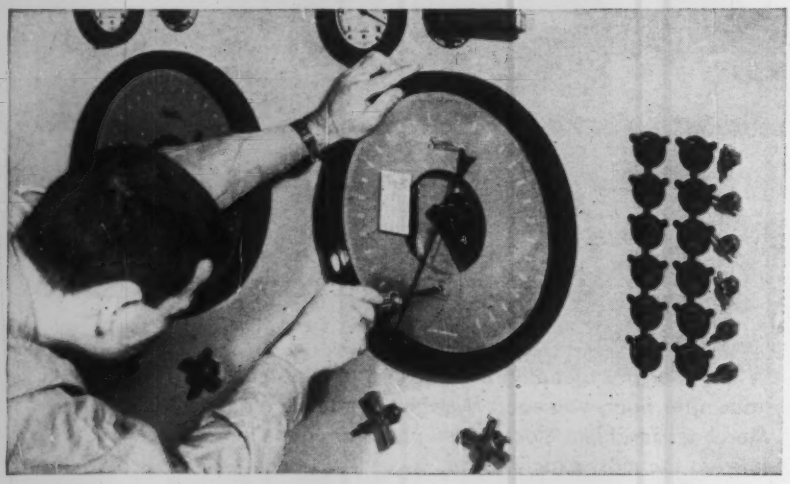
WALLACE & TIERNAN INC.

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 95 ON READER-SERVICE CARD



Guaranteed accurate
not only when it leaves our factory
but also after field recalibration

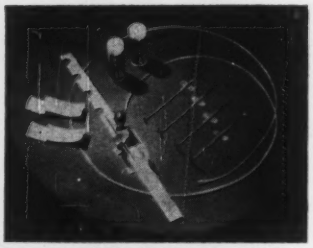


You can recalibrate Seegers precision test gauges to their original accuracy of 0.10% FS over their entire pressure range. Simple screwdriver adjustment takes only a few seconds and requires no special tools or testing equipment. Only Seegers gauges have this *true* recalibration capability. Other product superiorities include Ni-Span C and stainless steel components, eye-ease green dial with white increments linear to ±.001", and bourdon bleed and flush valve as standard equipment. *Write for a copy of our comprehensive technical bulletin.* **Seegers Instrument Company**

515 West Main Street, Barrington, Illinois SGS-1-200

CIRCLE 96 ON READER-SERVICE CARD

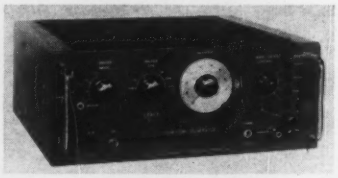
PEN CONVERSION KIT



New Mark-Trol Universal Conversion Kit contains a smooth-writing pen, replaceable cartridge ink supply, and sealed capillary system. Pen is easily installed in place of present marking devices. Eliminates problems of dust, dirt, moisture, etc.—*Esterbrook Pen Co., 200 Cooper St., Camden 1, N. J.*

CIRCLE 236 ON READER-SERVICE CARD

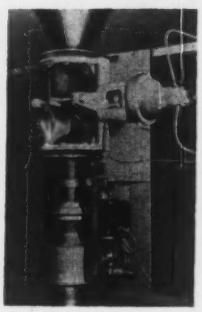
FUNCTION GENERATOR



New Type 250 Function Generator creates square, triangular, sine, cosine, and ramp waveforms with independent or simultaneous output of all five over frequency range from 0.001 to 10,000 cps. Unit features external triggering in addition to manual triggering and continuous operation; delivers 30 v at 25 ma at the main output or 30 v at 5 ma at auxiliary outputs. Reference level is variable for above and below-ground waveforms. Amplitude variation over the instrument's 10-million-to-one timing range is said to be under 5%.—*Exact Electronics, Inc., Box 234, Hillsboro, Ore.*

CIRCLE 237 ON READER-SERVICE CARD

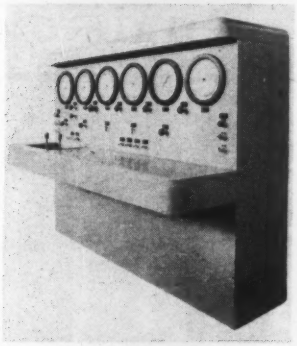
AUTOMATIC WEIGHING



New Automatic Weighing System with guaranteed accuracy ±1% includes new "IPI" Flo-Weight Controller, a combination of a pneumatically operated "pinch" valve and an "IPI" Dry-Flow Meter, which is constantly weighing the dry-flowing material. Any variation in a previously selected flow rate automatically results in a signal from the meter to the pinch-valve controller to correct rate of flow.—*Industrial Powertronix, Inc., 535 N. W. 11th Ave., Portland 9, Ore.*

CIRCLE 238 ON READER-SERVICE CARD

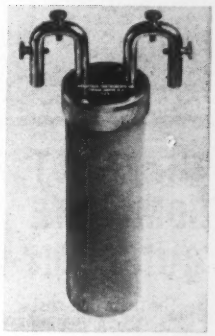
CALIBRATION CONSOLE



New Model PIC-121 Console for calibration and testing of pressure and vacuum gages, pressure transmitters and receivers, pneumatic and hydraulic devices, features performance capabilities: hydraulic—0-1000 psig; pneumatic—30" Hg vacuum to 100 psig; gage test fixtures—¼" and ½" size; accuracy—±0.1%—*Industrial Control Systems, Inc., Subs. of Customline Control Panels, Inc.*, 1379 *E. Linden Ave., Linden, N. J.*

CIRCLE 239 ON READER-SERVICE CARD

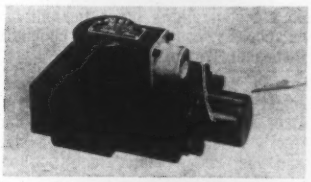
RESISTOR STANDARDS



New SR-Series Resistor Standards have bifilar wound resistor elements immersed in moisture-free oil for higher current ratings and temperature equalization. Heavy duty leads permit series or parallel connection without departure from guaranteed limits.—*Industrial Instruments, Inc, 89 Commerce Rd., Cedar Grove, Essex Co., N. J.*

CIRCLE 240 ON READER-SERVICE CARD

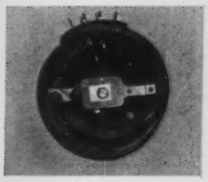
SERVOVALVES

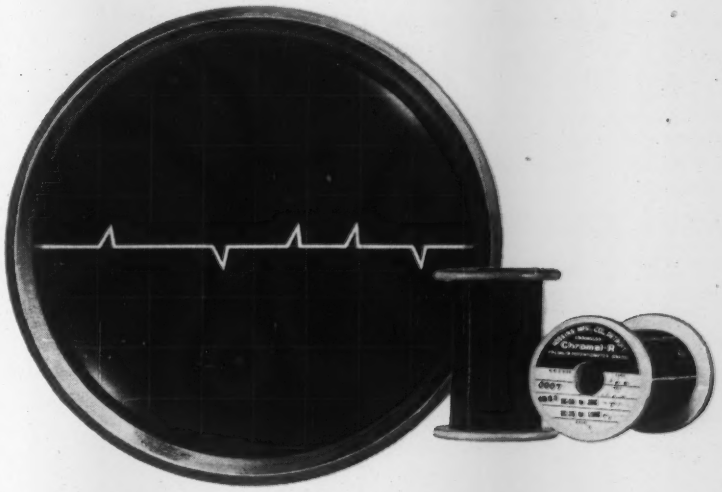


New Series-73 Industrial Servovalves, available in flow ratings of 1, 2½, 5, 10 and 15 gpm at 1,000 psi pressure drop and maximum signal, feature high spool positioning force, large pilot-stage filter, operational separate pilot supply port. Pilot operated, closed center, four-way sliding spool valves have advantage of completely symmetrical design, which minimizes null shift due to pressure or temperature changes.—*Moog Servocontrols, Inc., Industrial Div., Box 8, East Aurora, N. Y.*

CIRCLE 241 ON READER-SERVICE CARD

How to produce precision potentiometers having LOWER Equivalent Noise Resistance

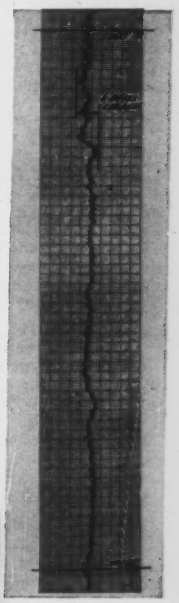




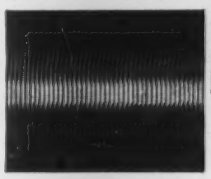
Use Hoskins Chromel-R

Premium Potentiometer Grade 800-Ohm Wire

B.C.—Before Chromel-R, that is—a spool of resistor wire having only 200 ohms of equivalent noise resistance was considered best obtainable by producers of precision potentiometers. Because then—as now—the lower the E.N.R. in the wire when received, the less cleaning and testing there is to be done to control the noise level in a finished wire-wound potentiometer. And the lower the electrical noise level is in a given potentiometer, the greater its stability and reliability in service.



Since Chromel-R, however, a good many producers of good precision potentiometers have come to regard wire having 200 ohms of E.N.R. in an entirely different light. Why? Because they have found—as you will, too—that E.N.R. in Chromel-R is controlled to much lower levels. Matter of fact, every foot of this premium potentiometer grade wire is unconditionally guaranteed to have less than 40 ohms of equivalent noise resistance as it comes off the spool. Its linearity of wire resistance is also guaranteed to be within close specified limits. And its superior roundness and surface finish permits more efficient winding of mandrels with greater uniformity of spacing between turns.



Want sample spools—plus technical data—for testing and evaluation? Your request on company letterhead will receive prompt attention!

HOSKINS MANUFACTURING COMPANY

4445 Lawton Avenue • Detroit 8, Michigan • Tyler 5-2860

In Canada: Hoskins Alloys of Canada, Ltd., Toronto, Ontario

Producers of Custom Quality Electrical Resistance, Resistor and Thermoelectric Alloy Since 1908

Tone shading derived from Alfax Paper captures more information in this recording of the ocean bottom.

Above is example of how you can get instant graphic recording with ALFAX electrosensitive PAPER.

Progressive innovators are obtaining vital information never before possible *and often unsuspected* in such fields as . . .

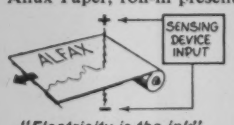
- **LONG RANGE RADAR DETECTION**
  As opposed to scope cameras, operator sees returns instantly, evaluates more rapidly, gets permanent record with increased sensitivity.
- **RADAR SAMPLING**
  Tone shades keyed to signal intensity provide vivid "picture" of radar return even when bulk of data is gated out.
- **SONAR ACTIVE AND PASSIVE**
  Unparalleled identification and location of returns even in poor signal to noise ratio through integrating capability of Alfax paper.
- **OCEANOGRAPHY**
  High resolution capability, dynamic tone shade response with Alden recording techniques adding synchronizing ease provide "optimization" of underwater sound systems.
- **FREQUENCY ANALYSIS, SAMPLING AND REAL TIME**
  Intensity modulation and frequency vs. real time provide continuous vital information with permanence and past history to achieve previously unattainable evaluation.
- **SEISMIC STUDIES**
  Dynamic response at high writing speeds yields discrete geological data at resolution never before possible.
- **HIGH SPEED FACSIMILE**

Why? Because of
ALFAX EXCLUSIVES

- **broad, dynamic response of 22 distinct tone shades**
- **remarkable expansion at low level signal, where slight variation may provide critical information**
- **records in the sepia area of the color spectrum where the eye best interprets shade differentials in diminishing or poor light**
- **writing speed capabilities from inches per hour up to 1400 inches/second**
- **captures 1 microsecond pulse or less**
- **dynamic range as great as 30 db**
- **integration capability for signal capture in signal to noise ratio conditions worse than 1 to 4**
- **resolution capabilities of 1 millisecond = 1 inch of sweep**
- **accuracy capabilities of few thousandths of an inch**
- **sensitivity to match most advanced sensing devices**

By merely passing a low current through Alfax everything from the faintest trace signal of microsecond duration to slow but saturated signal can be seen instantly, simultaneously.

Alfax Paper, roll-in presentation recorder labs and component recorders for your own experimentation are all readily available.



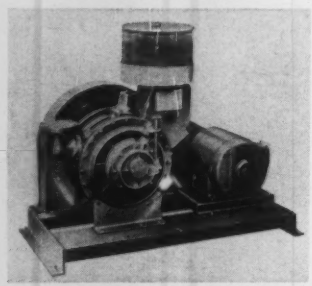
"Electricity is the ink"

Write for more facts to . . .

ALFAX

CIRCLE 97 ON READER-SERVICE CARD

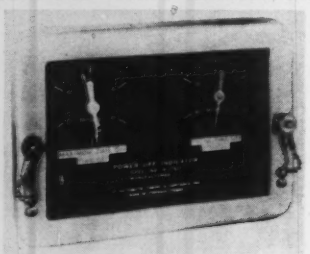
VACUUM PUMP



New Model 1398, Duo-Seal Vacuum Pump features capacities in excess of 50 cfm (1400 liters/min), low pressures, down to 1 x 10^{-4} mm Hg (McLeod) or better, vibration-free operation, air-cooled vented exhaust valve. Typical uses are electron tube evacuation, vacuum distillation, metal processing, leak detection, etc.—*Welch Scientific Co.*, 1515 *Sedgwick St., Chicago* 10, *Ill.*

CIRCLE 242 ON READER-SERVICE CARD

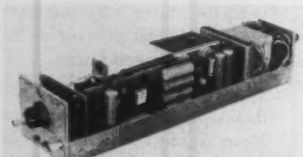
ELAPSED TIME INDICATOR



New Atcotrol Elapsed Time Indicator provides visual check of power interruptions. Tied in with power supply of temperature-controlled components for missiles from final assembly to the moment of launching, it has two timers in one package which are inoperative while power is on. When power fails, pointers on both dials move clock-wise and continue rotating as long as power is off. When power resumes, left hand pointer resets to zero and other pointer holds its position. Timer on right hand side accumulates total off-time for any number of power interruptions.—*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

CIRCLE 243 ON READER-SERVICE CARD

STRAIN GAGE POWER SUPPLY



New Model 1120 transistorized Strain Gage Power Supply provides d-c voltage range 3 to 30 v and d-c current range 0 to 100 ma at 0.01% drift.—*Cubic Corp.*, 5575 *Kearny Villa Rd., San Diego* 11, *Calif.*

CIRCLE 244 ON READER-SERVICE CARD

Genisco

*apd

ANALOG TO PULSE DURATION INSTRUMENTATION

HERE'S THE FIRST SMALL COMPLETE DATA-ACQUISITION SYSTEM The new low-cost Genisco APD Data Acquisition system is a complete and compact solid-state packaged system designed to meet a wide range of instrumentation requirements. You can use it to read out thermocouples, resistance thermometers, strain-gage transducers or any other DC voltage low-impedance sensors. Modular plug-in board design allows great flexibility—one chassis can provide a complete 20-channel system.

Data is sampled at 20 samples per second; repeatability is 0.1% of full scale. Output can be shown or recorded directly in engineering units with sign indication and channel identification. Readout can be converted to punch tape, magnetic tape, typewriter or other storage medium.

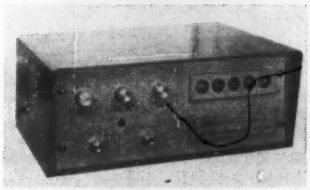
The new Genisco APD requires low power and is ideal for portable, laboratory, or field use. Call or write today for prices and complete details.

*Patent Applied For

Genisco
INCORPORATED
2233 Federal Ave., Los Angeles 64, California

CIRCLE 98 ON READER-SERVICE CARD

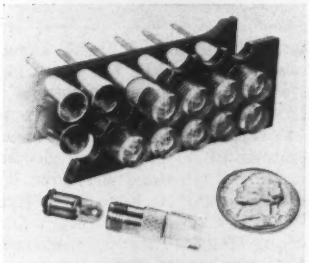
DATA ACQUISITION SYSTEM



New solid-state modular 10-Channel Analog-to-Pulse Duration (APD) Instrumentation System is an inexpensive data acquisition system used in conjunction with thermocouples, resistance thermometers, or strain-gage transducers to monitor, record, or control temperature, pressure, stress, or voltage. Inherent accuracy is 1 part in 1000 full scale, regardless of range. Operates at 20 samples/sec for acquisition of static or quasi-static data. Features automatic data reduction, with direct digital presentation of information and channel identification by means of transistorized decade counters with Nixie display.—*Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

CIRCLE 245 ON READER-SERVICE CARD

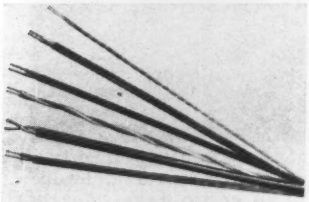
LAMP ASSEMBLY



New RLA-Series Replaceable Lamp Assembly uses standard miniature-flange-base neon or incandescent lamps. Twelve lens colors, transparent and translucent, in flat top and an optional watertight design available. Terminal-socket assemblies provide continuous straight-line light displays.—*Tec-Lite Div. Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.*

CIRCLE 246 ON READER-SERVICE CARD

T/C EXTENSION WIRE



New line of Insulated Thermocouple Wire is rated to 1800°F, for every environmental condition. Highest quality material is carefully calibrated.—*Trinity Equipment Corp., Cortland, N. Y.*

CIRCLE 247 ON READER-SERVICE CARD

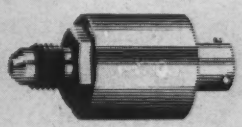
HOW MUCH SHOULD A TRANSDUCER COST?

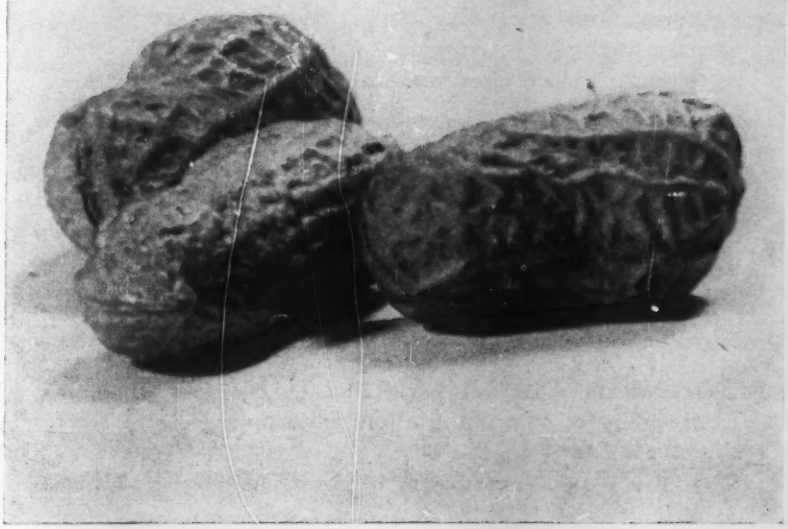
$100? $500? $2,000? It depends. How small must it be? How severe is the application? What accuracies must it perform to? All determine the price. Servonic's L-113 was developed for a missile program at a company sponsored cost of nearly $50,000. It sells for $400 in quantity. Here's why. It weighs only 1.7 oz. and measures 1″ x 1″, yet it will withstand 100 g acceleration with an error of less than 1%. A patented force summing mechanism is utilized to detect pressure change which is transmitted as a proportional linear movement through a metallic belt linkage to the wiper of a precision potentiometer. This is accomplished by an aneroid capsule connected to the inlet pressure fitting. Pressure media are contained within the aneroid capsule, isolated from the electrical component to enable operation in deleterious atmospheres without adverse effects. Wipers are precious metals. Platinum alloy wire is used as the resistance element. Forty-seven separate operations go into assembly of every unit—each individually checked for quality and reliability.

We'll be pleased to price out a unit for your particular requirements. Write for further details on the L-113.

SERVONIC INSTRUMENTS, INC.

Manufacturers of pressure transducers, pressure switches, rectilinear potentiometers and slip ring assemblies.
1644 Whittier Avenue, Costa Mesa, California.





CIRCLE 99 ON READER-SERVICE CARD

NEW BLH MICROMINIATURE AMPLIFIER IS SMALLEST, MOST RELIABLE UNIT AVAILABLE AT ITS PERFORMANCE LEVEL

Top Performance in Miniature... less than one cubic inch of:

Power—gains of 10, 20 and 200, with other gain values available.

Stability—better than ±15 microvolts referred to the input and to a given temperature, including all effects of use and environment.

Capability—operating temperature range from −100°F through 350°F with no sacrifice in output at either extreme. Vibration and shock resistance are transistor-limited only.

Linearity—terminal linearity better than ±.05% of full scale.

Diversity—many applications in ground support systems, integral transducer amplification, analog computers, low level commutations, plus many other electronic products and systems.

See for yourself the unlimited possibilities this tiny new amplifier offers. For complete specifications on the Model 700 Amplifier write us or contact one of the 17 BLH sales engineering representatives throughout the U.S. and in Canada.

BALDWIN • LIMA • HAMILTON
Electronics & Instrumentation Division
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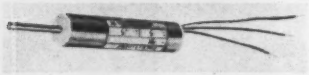
FIRST in force measurement

SR-4* Strain Gages • Transducers • Temperature Sensors • Systems

CIRCLE 100 ON READER-SERVICE CARD

TRANSLATORY POTENTIOMETERS



New custom-built Translatory Potentiometers with either cermet or wire-wound resistance elements measure linear motion directly. Wire-wound units operate at ambients −55° to 125°C, with life expectancy approximating 500,000 cycles. Ceramic/metal elements have ambient temperature range of −75° to 200°C, with 5-million-cycle life expectancy. Resistance ranges in the combined lines vary from 200 ohms/" to 140,000 ohms/".—*Helipot Div., Beckman Instruments, Inc.*, 2500 *Fullerton Rd., Fullerton, Calif.*

CIRCLE 248 ON READER-SERVICE CARD

DECADE ATTENUATORS

New modular Model DA-1 Decade Attenuator covers 0 to 111 decibels in steps of 0.1 db and consists of 3 shielded decades. Model DA-2 incorporates 2 decades and covers 0 to 110 db in steps of 1. Individual decades evolve from 4 shielded resistive "T" network attenuation pads having respectively 1, 2, 3 and 4 units of attenuation. Heavy duty cam operated switches connect pads in proper sequence to obtain 10 units of attenuation.—*Industrial Instruments, Inc.*, 89 *Commerce Rd., Cedar Grove, Essex Co., N. J.*

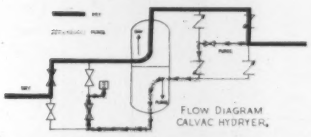
CIRCLE 249 ON READER-SERVICE CARD

PERMEAMETER

New Permeameter, a double hypernik-yoke magnetic bridge for measuring entire demagnetization curve of permanent magnets uses precision Hall probes. H and I can be measured simultaneously.—*Instrument Systems Corp., Halltest Div.*, 129-07, 18 *Ave., College Point* 56, *L. I., N. Y.*

CIRCLE 250 ON READER-SERVICE CARD

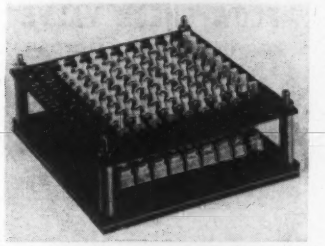
GAS/AIR DRYER



New CAL-VAC HYDRYER reactivates solid adsorbent without use of heating energy or cooling water. Twin-chambers in single vertical vessel provide continuous drying of air and/or gases. Operates on partial pressure differentials. Bulletin 162-O. —*J. F. Pritchard & Co. of Calif.*, 4625 *Roanoke Pkwy, Kansas City* 12, *Mo.*

CIRCLE 251 ON READER-SERVICE CARD

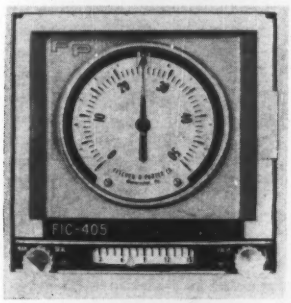
X-Y PLUGBOARD



New single-contact Sealectoboard provides individual, isolated terminations for every coordinate point on matrix. Upper deck provides common bussed line for combining parallel input signal, lower deck with individual contacts permits distribution of combined output to isolated or associate circuitry. Permits multiple output from single signal source. Used as switching device or component interpositioner.—*Sealectro Corp.*, 139 *Hoyt St., Mamaroneck, N. Y.*

CIRCLE 252 ON READER-SERVICE CARD

MINI CONTROL STATION



New Series 1214 miniature Indicating Control Station features optional scanning-type gage which permits vertical positioning of set point ("12-o'clock position") regardless of actual set point value. 3-15 psig input actuates Bourdon tube or Ni-Span-C diaphragm-type element. Accuracy of Bourdon tube is ±0.35%, sensitivity is 0.25%. Accuracy and sensitivity of diaphragm element are ±0.25% and 0.1%, respectively.—*Fischer & Porter Co.*, 3 *Jacksonville Rd., Warminster, Pa.*

CIRCLE 253 ON READER-SERVICE CARD

Perfect
ELECTRICAL Control

G-A CUSHIONED SOLENOID OPERATED VALVE

Where remote control valve operation is desired, specify and use the G-A Cushioned Solenoid Operated Valve that automatically opens or closes on any type of electrical impulse. The operating sequence—whether on open or closed circuit—can be made to suit your requirements. Sizes 2" to 36"

Bulletin W-7A has the complete story.

GOLDEN ANDERSON Valve Specialty Company

1286 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

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INSTRULAB'S

Temperature Compensated

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Constant Voltage Unit

Replaces Batteries and All Standardizing Components Including Standard Cell In

POTENTIOMETERS

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Mfg. By INSTRULAB, INC.

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Dayton 4, Ohio
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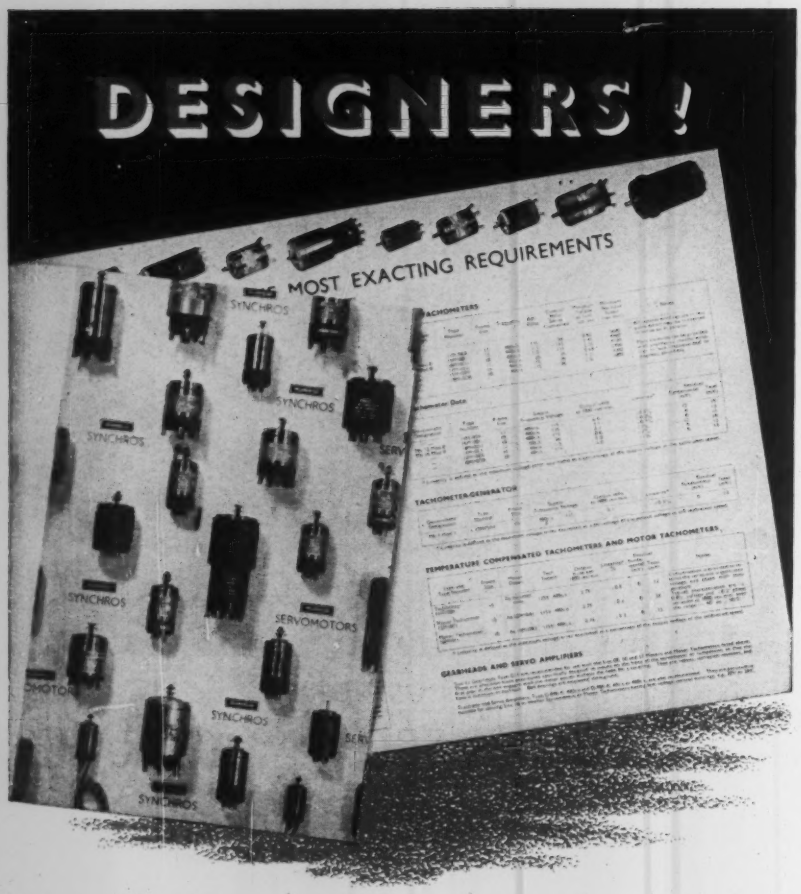
Outstanding FEATURES

- Eliminates batteries ...errors due to battery exhaustion
- Reliable construction...from quality components, long, trouble-free service
- A Precise voltage regulator . . . max. ±.04% for ±20% voltage variation
- Quickly Installed... Fits present instrument battery space.
- No Tubes to replace

CIRCLE 102 ON READER-SERVICE CARD



THE MUIRHEAD RANGE OF SYNCHROS—AT A GLANCE—

This revised issue of the Muirhead Synchro Broadsheet is available to all those interested in servo engineering. Prepared for easy reference, it presents the brief specifications of Muirhead Control Synchros, Torque Synchros, Resolvers, Two-Phase Servomotors, Motor Tachometers, Tachometer-Generators, Linvars and Gearheads in Standard Synchro frame sizes.

Also available — four sectional catalogues of data sheets giving full specifications on Control Synchros, Torque Synchros, Computing Components and Servomotors (Motor-Tachometers and Tachometer-Generators).

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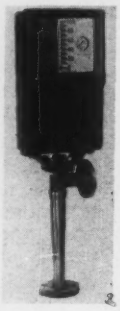
527

CIRCLE 103 ON READER-SERVICE CARD

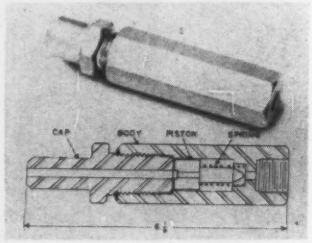
ROTAMETER TRANSMITTER



New Pneumatic Varea-meter Transmitter features plug-in components and float-position sensing device positioned over entire float travel by powerful pneumatic servo system which responds to change of only 0.07% with repeatability within 0.33% and linearity better than 0.5%, all of full scale.—*Wallace & Tiernan, Inc.*, 25 *Main St., Belleville* 9, *N. J.*

CIRCLE 254 ON READER-SERVICE CARD

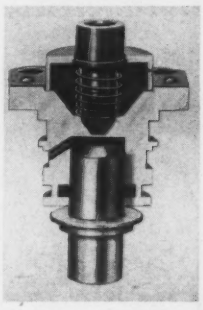
FLOW CHECK VALVE



New Excess Flow Check Valve provides either complete closure or a very slow calibrated leak, when flow through pipe exceeds pre-determined rate.—*Chemiquip Co.*, 36 *E.* 10 *St., New York* 3, *N. Y.*

CIRCLE 255 ON READER-SERVICE CARD

PRESSURE INDICATORS



New Pressure and Differential-Pressure Indicators in Deltadyne® line operate on a magnetic principle, eliminate need for mechanical linkages. Available for working pressures to 10,000 psi, operating temperatures −65° to 275°F and actuation from 1.5 to 100 psid.—*Pall Corp.*, 30 *Sea Cliff Ave., Glen Cove, N. Y.*

CIRCLE 256 ON READER-SERVICE CARD

SURFACE T/C

New Monitemp Mark IV Thermocouple for surface temperatures uses a powerful Alnico V magnet with the spring-loaded probe fitting through the center of the magnet. Available in either Chromel-Alumel or Iron-Constantan in any length.—*Advanced Products Co., North Haven, Conn.*

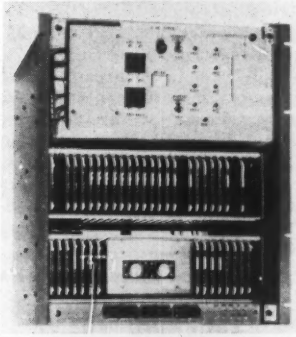
CIRCLE 257 ON READER-SERVICE CARD

TAPE SYSTEM

New Hypertape System employs cartridge-loading technique. IBM7340 Hypertape Drive and 7640 Hypertape Control linked to IBM 7074, 7080 and 7090 computers enable these to read and write numbers at speeds up to 340,000/sec, letters at rate of 170,000/sec, or typical combination of numbers and letters up to 250,000/sec. (Example: at top speed, Hypertape could enter all 137 million U. S. Social Security numbers into a computer in an hour).—*International Business Machines Corp., Data Processing Div., 112 E. Post Rd., White Plains, N. Y.*

CIRCLE 258 ON READER-SERVICE CARD

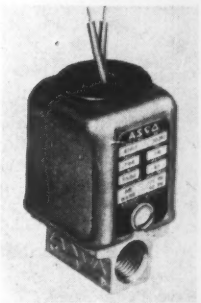
CORE-MEMORY SYSTEMS



New series of 4 models transistorized high-speed random-access Magnetic-core Memory Systems has storage capacities ranging from 20,480 to 163,840 bits, access times of 2.5-4.0 μsec and read-write cycle times of 5-10 μsec.—*Computer Control Co., Inc., 983 Concord St., Framingham, Mass.*

CIRCLE 259 ON READER-SERVICE CARD

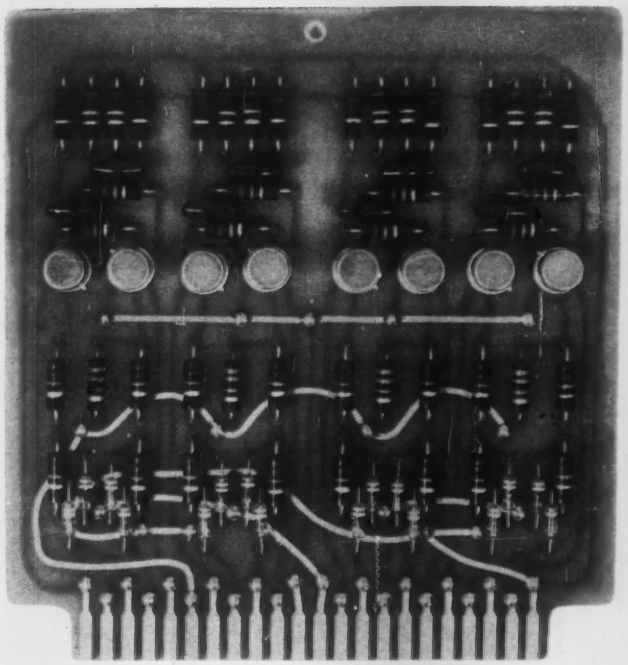
SOLENOID OPERATED VALVE



New direct-acting midget 2-way packless N-C Solenoid-operated Valve has ⅛" or ¼" pipe connections and 3/32" orifice. Bulletin 8261, Form V5156.—*Automatic Switch Co., Florham Park, N. J.*

CIRCLE 260 ON READER-SERVICE CARD

START RIGHT



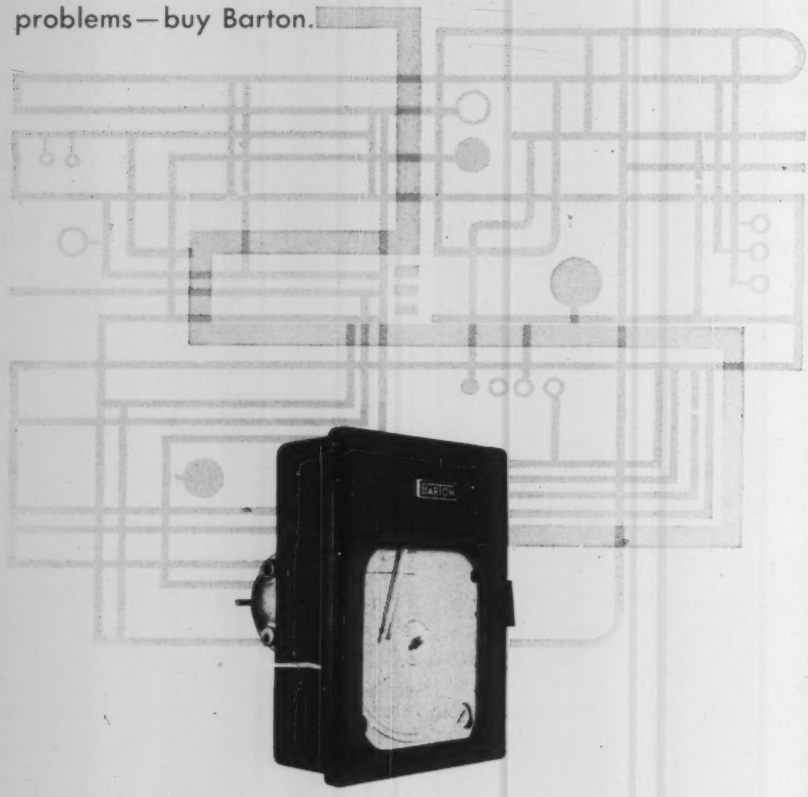
Start right when you design a solid-state electronic system. Select the line of digital circuit modules that gives you (1) maximum freedom of design and (2) minimum cost. Ransom Research offers the broadest selection of circuits (well over 100 "off the shelf") *and* lowest cost per circuit (average 25% less). Specify Ransom. *New Condensed Catalog C now available on request.*

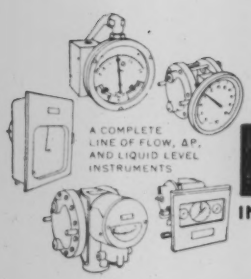
RANSOM RESEARCH A DIVISION OF WYLE LABORATORIES
Box 269, 374 West Eighth Street San Pedro, California TErminal 2-1128

CIRCLE 104 ON READER-SERVICE CARD

PROCESS SYSTEM RELIABILITY BEGINS WITH BARTON INSTRUMENTS

Sooner or later, excessive maintenance, costly inaccuracy and questionable dependability are the problems you face with many differential pressure instruments—but not with Barton. Built on the original, patented, rupture-proof dual-bellows principle, all Barton instruments—indicators, recorders, switches, transmitters, controllers, integrators—deliver unerring accuracy, minimum maintenance, immunity to effects of overranging and, above all, unmatched dependability. Whatever the application, whatever the instrument need, don't buy problems—buy Barton.

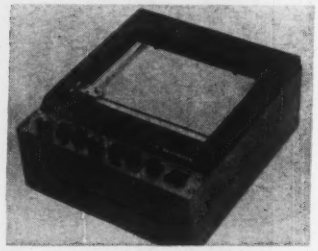




BARTON
INSTRUMENT CORPORATION • MONTEREY PARK, CALIF.

CIRCLE 105 ON READER-SERVICE CARD

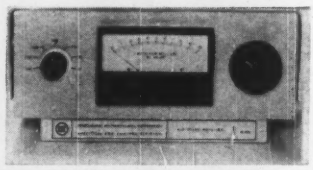
X-Y RECORDER



New low-cost null-seeking servo-type Recorder responds to two simultaneous d-c input voltages and plots curves in ink in Cartesian coordinates on 8½" x 11" paper. Available in two models with sensitivities of 1 mv/in and 10 mv/in, respectively.—*Central Scientific Co., Subs. of Cenco Instruments Corp., 1700 W. Irving Park Rd., Chicago 13, Ill.*

CIRCLE 261 ON READER-SERVICE CARD

MOISTURE MONITOR



New Model 26-303 portable coulometric-electrolytic Moisture Monitor has highly accurate, adjustable flow-control system and rugged plug-in electrolytic cell, features fast response to changes in water content in sample-stream. Trace water in gases or gaseous mixtures from less than one to 1000 ppm water by volume can be measured.—*Consolidated Electrodynamics Corp., Subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.*

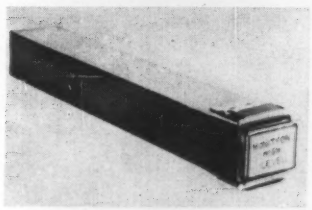
CIRCLE 262 ON READER-SERVICE CARD

SOLENOID VALVE

New Type 205 2-way miniature packless Solenoid Valve has cushion action and controlled linear flow which minimize hydraulic line shock. Handles differential pressures from 0 to 400 psi and hydraulic or pneumatic media at temperatures from −45° to 185°F. Resilient seal is bubbletight.—*Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.*

CIRCLE 263 ON READER-SERVICE CARD

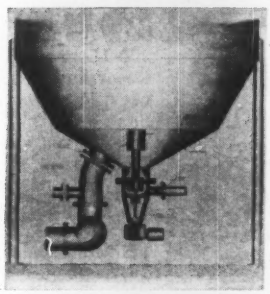
MINI ANNUNCIATOR



New 1200-Series solid-state miniaturized Annunciators are for close monitoring applications where it is desirable to acknowledge each alarm separately. Windows serve also as press-to-acknowledge switches. Standard push button switches for manual reset where required. Bulletin.—*Radiation Technology, Inc.*, 657 *Antone St., N. W., Atlanta* 18, *Ga.*

CIRCLE 264 ON READER-SERVICE CARD

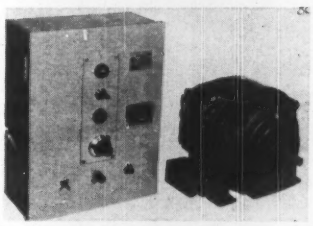
STOCK UNLOADER



New Royalve Tank Unloader for semi-viscous material of various densities consists of slowly revolving "mining-type" head with integral shrouded nozzle installed at bottom of storage tank or tower. Two streams of high pressure water slice off stock and deliver it to the unloading pipe.—*W. G. Rovang & Assoc., Inc.*, 1945 *N. Columbia Blvd., Portland* 17, *Ore.*

CIRCLE 265 ON READER-SERVICE CARD

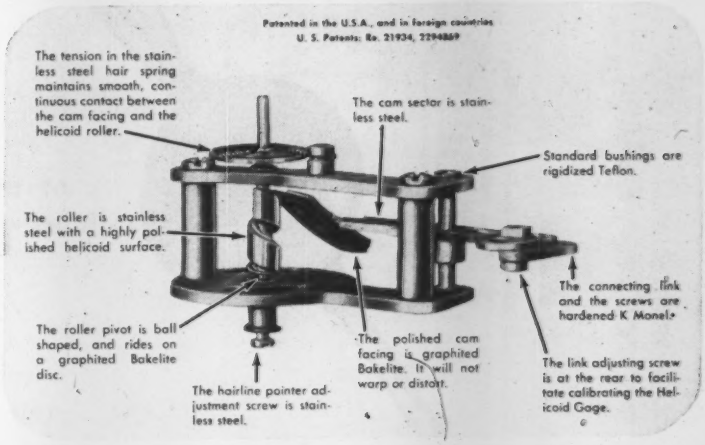
VARIABLE SPEED DRIVES



New Variable-speed Drives in line of Magne-Speed® with silicon-controlled rectifiers in conjunction with magnetic trigger and other solid-state circuitry are used for precise control of d-c shunt motors in range of ¾ to 5 hp. Features include NEMA enclosures, modular construction and circuit design, optional tachometric feedback, reversing, dynamic braking, and remote control.—*Siegler Corp., Magnetic Amplifiers Div.*, 632 *Tinton Ave., Bronx* 55, *N. Y.*

CIRCLE 266 ON READER-SERVICE CARD

ACCO Helicoid Gage U.S.A.


Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details Ask for Catalog DH-65

HELICOID GAGES

ACCO

Helicoid Gage Division • American Chain & Cable Company, Inc.

929-B Connecticut Ave., Bridgeport 2, Conn.

CIRCLE 106 ON READER-SERVICE CARD

READ

any surface temperature in 3 seconds with

Alnor PYROCON®

Particularly, in the lower temperature range, the Alnor Pyrocon has extreme accuracy unmatched by any other instrument of its type.

Alnor offers the widest variety of interchangeable tips for reading temperatures on metallic or non-metallic, flat, curved, revolving or stationary surfaces as well as semi fluid materials, plastics, liquids, molten or soft metals, dies, rubber, waxes and many other surface or subsurface materials.

The Pyrocon is a compact, rugged instrument built with the highest standards of accuracy and dependability as well as speed in reading.

Eight models with temperature ranges from 0—300° F. to 0—2000° F. Write for bulletin 4257.

Alnor INSTRUMENTS

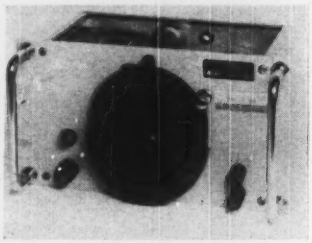
ALNOR INSTRUMENT CO.

Division of Illinois Testing Laboratories, Inc.

Room 518, 420 N. LaSalle St., Chicago 10, Illinois

CIRCLE 107 ON READER-SERVICE CARD

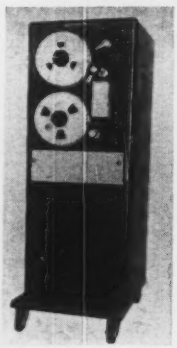
PHASE SHIFTER



New CO3 721 018 Phase Shifter in line of ground support equipment measures either known or unknown phase angle and provides constant output voltage, continuously variable in phase from 0° to 360°.—*Kearfott Div., General Precision, Inc.*, 1150 *McBride Ave., Little Falls, N. J.*

CIRCLE 267 ON READER-SERVICE CARD

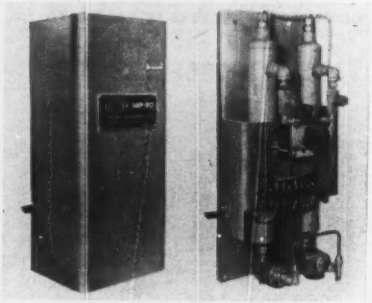
MAGNETIC DATA RECORDER



New 7-channel 4-speed low-cost Sanborn/Ampex Model 200 Magnetic Data Recording System uses ½" tape and has 3¾, 7½, 15 and 20 ips speeds. Maximum error due to non-linearity is 0.2%, maximum drift ±0.5% of full scale for 10-v power line change of 10°C ambient temperature change. Direct recording bandwidth is to 50,000 cps and FM bandwidth is to 5,000 cps.—*Sanborn Co., Industrial Div.* 175 *Wyman St., Waltham* 54, *Mass.*

CIRCLE 268 ON READER-SERVICE CARD

DESICCANT DRYER



New MP-60 Desiccant Dryer delivers air with dewpoint 100°F below ambient or better. Moisture is removed from inlet air as it passes up thru chamber of activated alumina desiccant. At end of 2-hour drying cycle, automatic timer switches valve positioners and diverts inlet air to second chamber for drying. Desiccant in other chamber is being reactivated by heat from a built-in heater and small flow of dry air used for purging.—*Trinity Equipment Corp., Cortland, N. Y.*

CIRCLE 269 ON READER-SERVICE CARD

Look to February 1962 issue of Instruments and Control Systems for expert treatment of this important control topic - - -

• PRESSURE INSTRUMENTATION

I&CS' READERS can look forward to a comprehensive display of highly informative and useful data.

MANUFACTURERS and designers of equipments and components for measurement and control of pressure will find this a particularly valuable medium in which to advertise.

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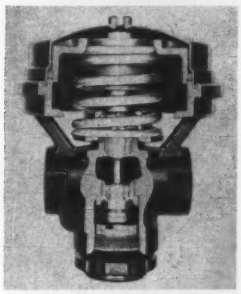
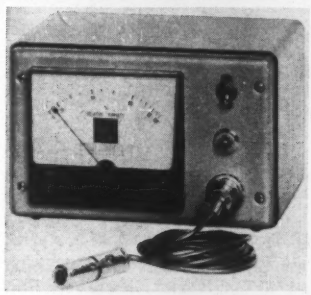
CYLINDER OPERATED VALVES



New 1000V-Series Cylinder-Operated Valves feature light weight, fast-acting actuation, leak-proof seal. Cylinder is made of heavy-gage anodized aluminum. Minimum travel time of piston is fraction of a second. Made for either two or three-way operation with rated service pressures of 300 or 500 psi.—*Taylor Instrument Cos., 95 Ames St., Rochester 1, N. Y.*

CIRCLE 270 ON READER-SERVICE CARD

HUMIDITY MEASURING DEVICE



New portable Humistat transistorized Humidity Meter features semiconductor sensing element whose electrical resistance changes instantly with changes in relative humidity. Conductivity of element is an exponential function of quality and dipole moment of material surrounding it; thus, its sensitivity to water vapor, ozone, etc., is high. Accuracy is ±2%. Bulletin.—*Telostat Corp., 1003 First St. South, Hopkins, Minn.*

CIRCLE 271 ON READER-SERVICE CARD

DYNAMIC PLASTICS TESTER

New Maxwell Dynamic Tester for plastics shows dynamic mechanical properties of plastics over wide frequency and temperature ranges. Consists of mechanical section with a strain-gage-instrumented stress dynamomenter, and control panel for adjusting temperature down to −40°C with dry ice or −70° with compressed CO_2, and up to 200°C.—*Testing Machines, Inc., 72 Jericho Tpk., Mineola, N. Y.*

CIRCLE 272 ON READER-SERVICE CARD

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SPECIALLY-DESIGNED CUSTOM PAPERS
for your special
RECORDING INSTRUMENT

Sophisticated instruments that chart critical variables demand sophisticated recording papers. That's why more and more recording instrument manufacturers are turning to Ludlow, patent holders of the first non-wax thermal and pressure sensitive chart papers.

Ludlow research and engineering design will go to work for you to create to your precise specifications the exacting, ultra-sensitive recording papers required to produce ultimate performance from a fine instrument... records free of failures or inaccuracies. Write Dept. CE-41 for literature and samples. Include your requirements or special problems.

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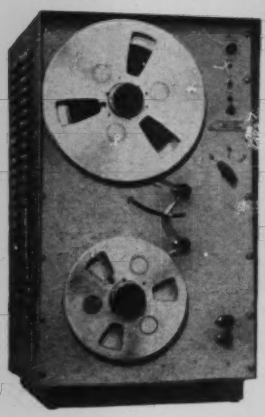
CIRCLE 108 ON READER-SERVICE CARD

TAPE TAMER



NEW EECO HIGH-SPEED MAG TAPE REWIND UNIT $690, 6 WEEKS DELIVERY

Tame your tape rewind problems at the industry's lowest cost for all these features. Fast automatic stop when tape ends or power fails. Rewinds 10½" reel in 75 seconds. Constant tension for unusually even winding. Tension selector. Universal hub accepts NAB, UNIVAC or IBM reels. Precision guides handle ½", ¾" or 1" tape without adapters. Unit takes reels up to 14" diameter. Operates on 115v ac, 60 cps, 150 va. Initial availability 6 weeks. Send for Data File TR-300.

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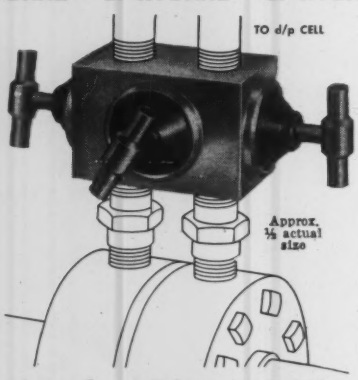
LOW COST VALVE MANIFOLDS ELIMINATE BY-PASS VALVES, FITTINGS, PIPING!



Dahl DEMI Miniature Packless Valves offer great porting versatility in isolating, routing and by-pass applications. For example... three-way manifold, used across a flow metering, differential sensing device allows it to be zeroed or isolated from line for test . . . reducing size and cost of installation.

Patented basic design offered in forty-three styles . . . with metal-to-metal seating, TEFLON seats, or neoprene diaphragms . . . all featuring bubble tight shut-off.

Low cost "DEMI G" valves, in ⅛" to ½" N.P.T. sizes, provide positive control in minimum space. Many actuating devices. Wide selection of construction materials.

REQUEST free 32-page Catalog D-1 for complete details. G. W. Dahl Co., Inc., 82 Tupelo St., Bristol, R. I.

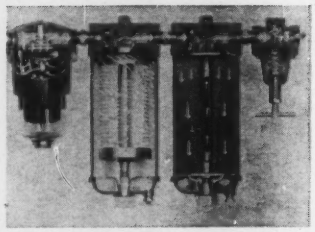
G. W. DAHL CO., INC.

SPECIALISTS IN COMPACT VALVES AND CONTROLS

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

CIRCLE 110 ON READER-SERVICE CARD

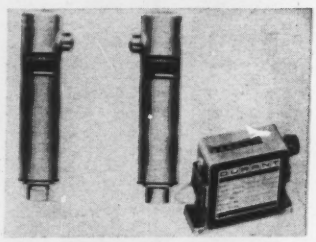
AIR DRYER



New compressed air Dehydrator drying air and ridding it of oil and dirt contaminants is rated at max of 10 scfm at 100 psi, lowers the dew point of air to −100°F., and removes oil to 2 ppm. First stage of unit has moisture separator with built-in automatic sump drain mechanism. Second stage is a filter that removes dirt as small as 3 microns in size, and oil fumes. No electrical or water connections are necessary.—*Wilkerson Corp.*, 1246 *W. Mansfield, Englewood, Colo.*

CIRCLE 273 ON READER-SERVICE CARD

PHOTOELECTRIC CONTROLLER



New photoelectric Control-Unit for Model 6-Y-1-RMF electric-counter is effective for range to ten feet and operates at speeds to 1200 counts/min.—*Durant Mfg. Co.*, 1914 *N. Buffum St., Milwaukee, Wis.*

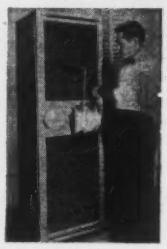
CIRCLE 274 ON READER-SERVICE CARD

PLASTIC INK RESERVOIR

New Plastic Reservior for Cannon Meter Pens has ink capacity for recording 250,000 inches without refilling. Pens, are available in five sizes and angles.—*American Meter Co.*, 920 *Payne Ave., Erie, Pa.*

CIRCLE 275 ON READER-SERVICE CARD

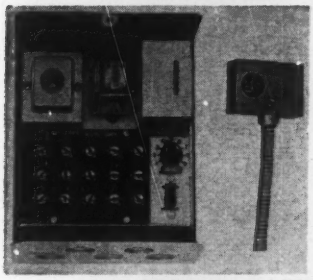
DATA ACQUISITION SYSTEMS



New series of highly flexible bimodal 1100-Series Digital Data Acquisition Systems made by C.G. Electronics Div., offers both simultaneous and sequential modes of operation, visual in-line display, maximum sampling speed, of 1000 samples/sec, punched paper tape output.—*Gulton Industries*, 212 *Durham Ave., Metuchen, N. J.*

CIRCLE 276 ON READER-SERVICE CARD

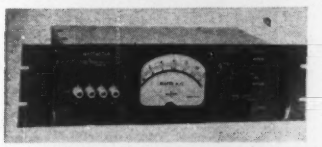
REGISTRATION CONTROL



New Type 23DF3 high-speed Photoelectric Impulse Controller is fully transistorized, operates on any small abrupt change in light reaching photoconductive cell. Ultra-compact Type 42RA1 Scanner (combination of light source and photoelectric receiver) has been designed for use with 23DF3 as a registration control.—*Photoswitch Div. Electronics Corp. of Amer., 1 Memorial Dr., Cambridge, Mass.*

CIRCLE 277 ON READER-SERVICE CARD

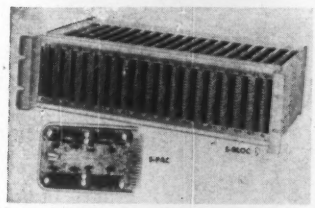
LOW POWER WATTMETER



New PW-Series rack-mounted Wattmeter for low-power measurements required by gyros, synchros and servo motors has lowest full range of 1.2 w, accuracy within 10% of power factor, flat frequency range 50 to 2000 cps with accuracy of 1% of full scale. Power factors are 0.2 to 1.0, lag or lead, for 50 to 200 cps and 0.1 to 1.0, lag or lead, for 200 to 2000 cps. Offered for one-, two- or three-phase operation.—*Voltron Products, Inc., 1020 S. Arroyo Pkwy., Pasadena, Calif.*

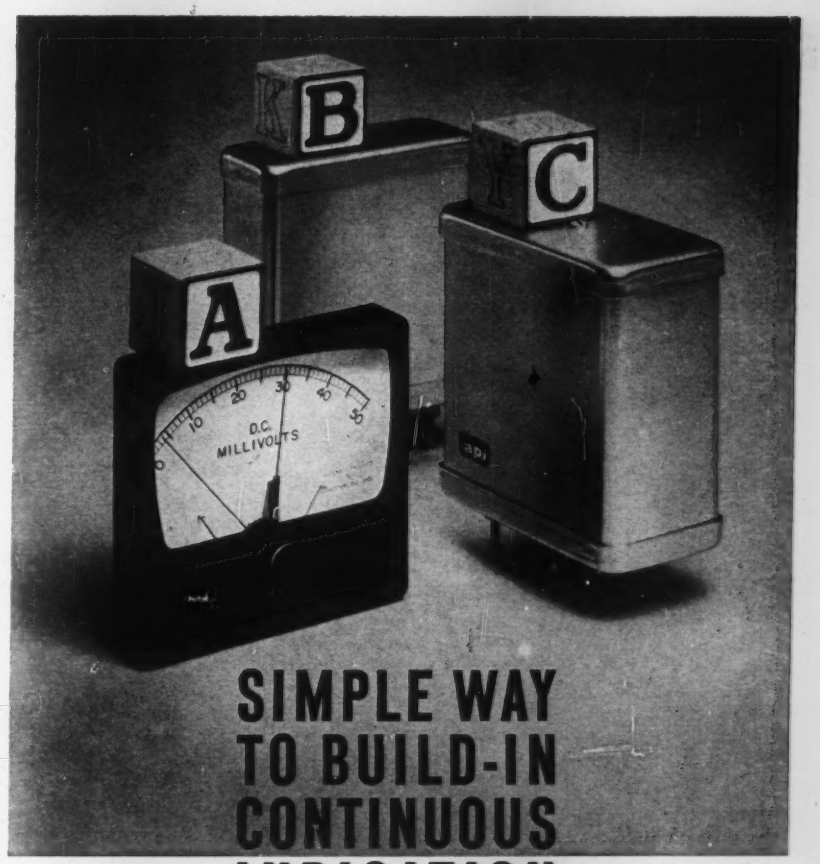
CIRCLE 278 ON READER-SERVICE CARD

DIGITAL MODULES



New series of low-cost high-reliability S-PAC Digital Plug-in Modules operates in dc-to-5-Mc frequency range, features transistor logic, high package density. In addition to flip-flops and other basic logic elements, line includes octal/decimal encoders and decoders, analog-to-digital converters, digital-to-analog ladder networks, Schmitt triggers, shift registers, and numerous special circuit boards.—*Computer Control Co., Inc., 983 Concord St., Framingham, Mass.*

CIRCLE 279 ON READER-SERVICE CARD



SIMPLE WAY TO BUILD-IN CONTINUOUS INDICATION AND CONTROL

It takes just three components to do the job. A Continuous Reading Meter-Relay (CRMR); a power supply; a load relay. Put them together and you have a complete control "system." With it you can add continuous indication and automatic on-off control to any equipment package. That's right—any equipment package. The CRMR will monitor and control any variable transduceable to current or voltage values—even at low, unamplified microamp or millivolt levels. • For the work it does, a CRMR control requires remarkably little space. The meter-relay itself (there are several case styles) requires only a meter-sized panel space. The power supply and load relay are plug-in units; you can mount them on one of our racks or directly on the equipment chassis. • If you are presently working on equipment that could use (or be improved by) continuous indication combined with discrete set-point control, you'd do well to have a look at our Bulletin No. 5. It will give you applicational information, detailed specs, and prices.

api

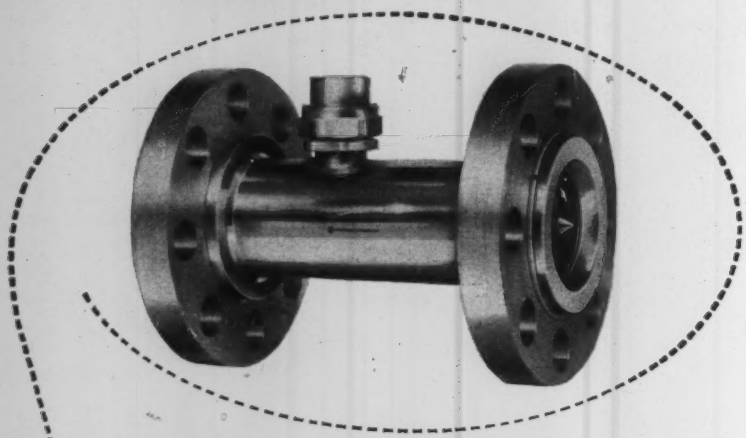
ASSEMBLY PRODUCTS INC.

Chesterland 10, Ohio

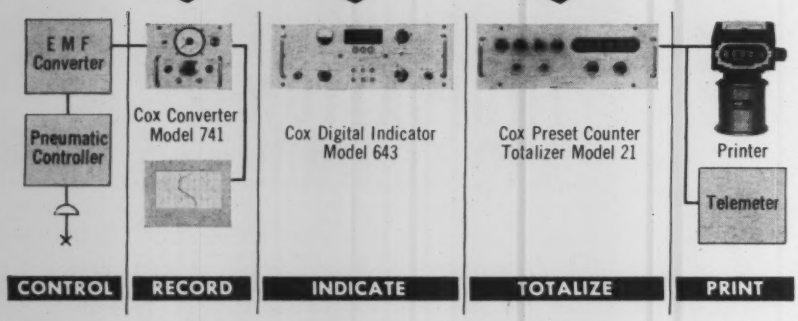
SA2459

CIRCLE 111 ON READER-SERVICE CARD

Start Right!



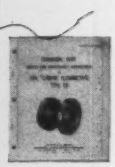
with **COX Turbine Flowmeters**



The most important element in any flow measurement or control system is the *primary* transducer. Start with a good signal and the final readout or control will be good. And, as many users are finding, a good way to start is with Cox Turbine Flowmeters. Here's why—

Signal output versus flowrate is extremely stable and is *±1/4% or better of actual flowrate* with rangeability as high as 65:1. Besides, Cox turbine flowmeters are rugged . . . usable with most fluids at extremes of temperature and pressure . . . and *are easily disassembled for cleaning in a matter of seconds without affecting calibration.* To insure complete system accuracy, Cox also builds auxiliary readout and control equipment.

For more information write *Cox Instruments, George L. Nankervis Company, 15300 Fullerton Avenue, Detroit 27, Michigan.*



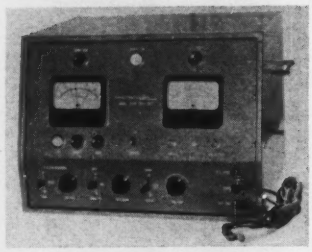
Write for Handbook on Cox Turbine Flow Measurement and Control Systems No. 3000.

COX INSTRUMENTS
GEORGE L. NANKERVIS COMPANY
Representatives in principal cities.

Subsidiary of PENINSULAR METAL PRODUCTS CORP.

CIRCLE 112 ON READER-SERVICE CARD

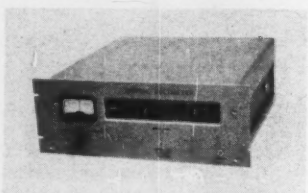
BREAKDOWN TESTING



New Model 8522 Test Set allows high voltage breakdown tests from 0 to 2.5 kv, a-c, with automatic readout of leakage current above a preset level and insulation breakdown, on separate signal lights; indication of continuity and ohms resistance on direct reading scales of 0-50 and 0-500 ohms. Has self-calibrating features.—*Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.*

CIRCLE 280 ON READER-SERVICE CARD

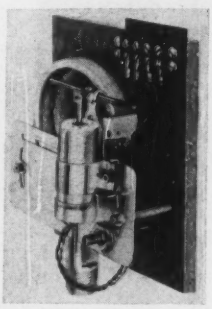
DIGITAL VOLTMETER



New Model 2000-Series a-c or d-c Digital Voltmeters are available optionally with facilities for programmed operation. 5-digit resolution is achieved by front panel meter which verifies null balance condition. Features include ± 1 digit accuracy, floating operation, 0.001% resolution, transistorized circuitry, optional printout, automatic range and polarity, and automatic test system capabilities.—*Auto Data, 943 Turquoise, San Diego, Calif.*

CIRCLE 281 ON READER-SERVICE CARD

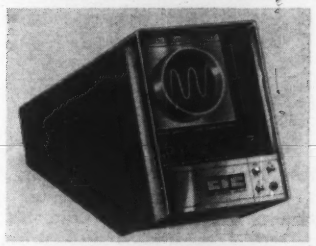
PRESSURE TRANSDUCER



New Class 6001-B Pressure Transducer has been equipped with new, improved differential transformer and Bourdon-tube assembly; has range to 10,000 psi. Accuracy based on calibrated performance is ±0.25% of full range from 15 to 5000 psi, and ±1.0% to 10,000 psi; repeatable accuracy ±0.1% of range. —*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

CIRCLE 282 ON READER-SERVICE CARD

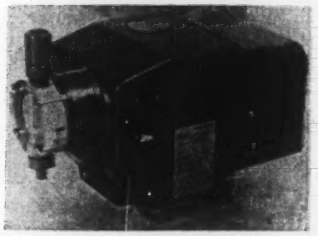
AUTOMATIC OSCILLOSCOPE



New Oscilloscope features automatic sweep speed, automatic sensitivity, and automatic positioning, solid-state circuitry. Range of vertical sensitivity and horizontal sweep are presented digitally on Nixie readouts, calibrated d-c offset on in-line display.—*California Instruments Corp.*, 3511 *Midway Dr., San Diego* 10, *Calif.*

CIRCLE 283 ON READER-SERVICE CARD

FEED PUMPS



New Series/100, positive-displacement diaphragm-type self priming Hypochlorinators and Chemical Feed Pumps feature ball bearing motors, unbreakable PVC fittings, non-corroding plastic case. Especially designed for water treatment.—*CHEM/TECH International*, 123 *Brimbal Ave., Beverly, Mass.*

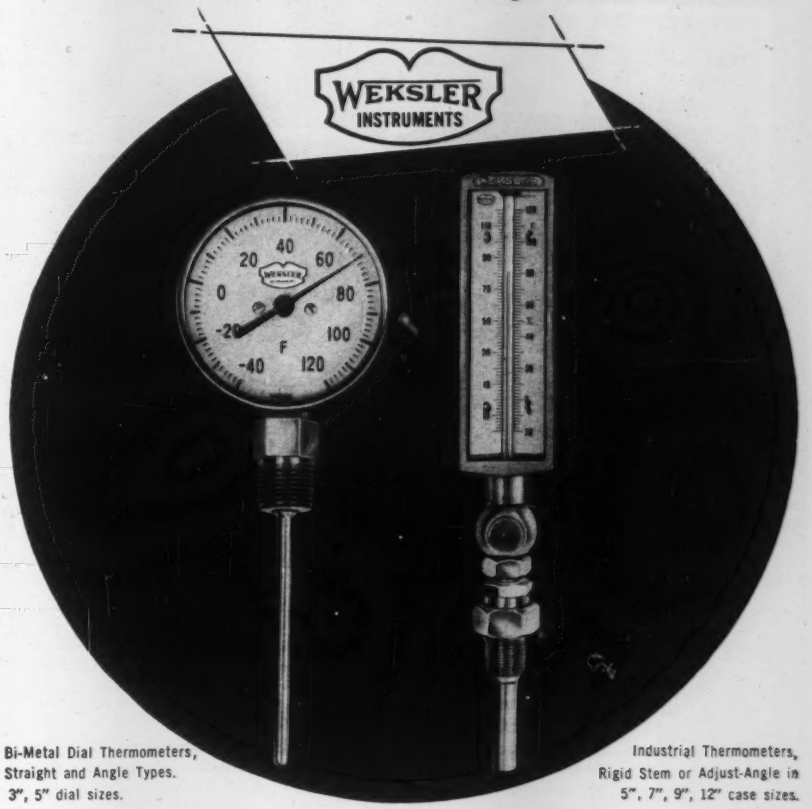
CIRCLE 284 ON READER-SERVICE CARD

FREQUENCY METER

New self-contained passive micrometer-tuned Wavemeter measures frequencies used in microwave relay links between 500 and 10,000 Mc. All frequency-sensitive elements use Invar to maintain accuracy of ±0.01% over a temperature range of −20 to 70°C. Resetability is ±0.005%. Tuning is accomplished through micrometer-type dial whose readings are converted to frequency by reference to a calibration chart furnished with each instrument.—*Frequency Engineering Labs., Box* 504, *Asbury Park, N. J.*

CIRCLE 285 ON READER-SERVICE CARD

SYMBOL OF QUALITY



Bi-Metal Dial Thermometers, Straight and Angle Types. 3", 5" dial sizes.

Industrial Thermometers, Rigid Stem or Adjust-Angle in 5", 7", 9", 12" case sizes.

in Liquid-In-Glass Industrial and Bi-Metal Thermometers

Indicating and recording instruments for temperature, pressure and humidity. *This is our one and only business.*

Our modern suburban plant, precision equipment and skilled people are here for one purpose:

To design, engineer, produce and deliver the most complete and finest line of instruments in our field of specialization that you'll find . . . *anywhere!*

The Weksler Specification Bulletin covers indicating and recording pressure gauges, industrial thermometers, dial thermometers, recording thermometers, recording hygrometers, bi-metal thermometers, laboratory thermometers and hydrometers. *Write for your copy.*

"ORIGINATORS OF WORLD RENOWNED ADJUST-ANGLE THERMOMETERS"

WEKSLER INSTRUMENTS

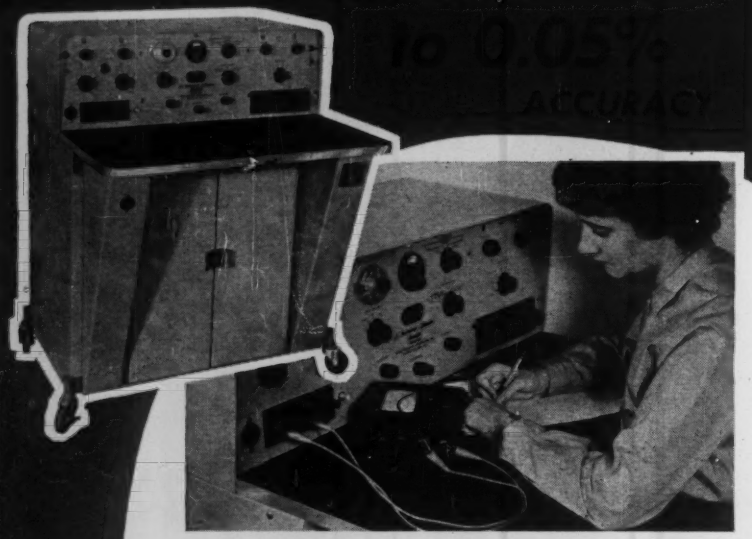
WEKSLER INSTRUMENTS CORP.

195 EAST MERRICK ROAD, FREEPORT, L. I., N. Y.

Indicating and Recording Instruments for Temperature, Pressure and Humidity

CIRCLE 113 ON READER-SERVICE CARD

AC Instrument Calibration



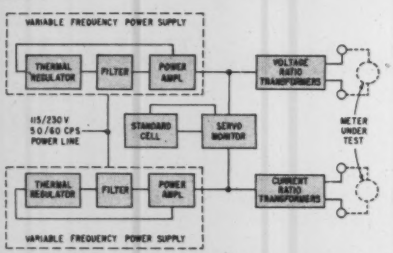
Voltmeters and ammeters, plus wattmeters, are quickly calibrated over frequencies from 50 to 2400 cps by one operator.

The Model 1967 Semi-Automatic AC Instrument Calibration Standard provides, in a single convenient console, a precise and rapid means for standardizing and calibrating alternating current wattmeters, expanded scale, digital, indicating and recording voltmeters and ammeters.

Basic accuracy is maintained by an AC reference source consisting of a servo amplifier, thermal transfer circuit and a sensitive light beam galvanometer all balanced against a ±.01% laboratory type standard cell. Resistive components are made of selected manganin properly heat-treated, aged for six months and adjusted to ±.01% of absolute value. The thermoelement is unaffected by waveform errors, has flat frequency response and is protected against overloads.

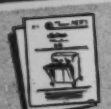
MODEL 1967 CALIBRATION RANGES

AC VOLTAGE		AC CURRENT	
RANGE	MIN. LOAD RESISTANCE	RANGE	MAX. LOAD RESISTANCE
0-1.5 MV	20,000 ohms	0-15 μA	10,000 ohms
0-3.0 MV	20,000 ohms	0-30 μA	10,000 ohms
0-7.5 MV	20,000 ohms	0-75 μA	10,000 ohms
0-15 MV	20,000 ohms	0-150 μA	10,000 ohms
0-30 MV	20,000 ohms	0-300 μA	10,000 ohms
0-75 MV	20,000 ohms	0-750 μA	10,000 ohms
0-150 MV	20,000 ohms	0-1.5 MA	1,000 ohms
0-300 MV	20,000 ohms	0-3.0 MA	1,000 ohms
0-750 MV	20,000 ohms	0-7.5 MA	1,000 ohms
0-1500 MV	1,000 ohms	0-15 MA	1,000 ohms
RANGE	**MAXIMUM LOAD**	**RANGE**	**MAXIMUM LOAD**
0-1.5 Volts	2 VA	0-0.15 Amp	10 VA
0-3.0 Volts	3 VA	0-0.3 Amp	10 VA
0-7.5 Volts	5 VA	0-0.75 Amp	10 VA
0-15 Volts	10 VA	0-1.5 Amp	10 VA
0-30 Volts	15 VA	0-3.0 Amp	10 VA
0-75 Volts	15 VA	0-7.5 Amp	10 VA
0-150 Volts	15 VA	0-15 Amp	10 VA
0-300 Volts	15 VA	0-30 Amp	10 VA
0-750 Volts	15 VA	0-75 Amp	10 VA
0-1500 Volts	15 VA		



We are specialists in the design and manufacture of instrument calibration consoles — offering more types than any other source in the world. Accuracy of all units is certificated and traceable to primary standards maintained by the National Bureau of Standards.

Performance is rigidly guaranteed. Prices are f.o.b. Boonton, N.J. and subject to change without notice.



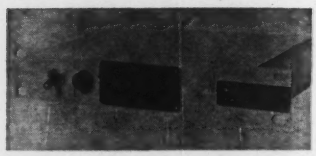
SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

CIRCLE 114 ON READER-SERVICE CARD

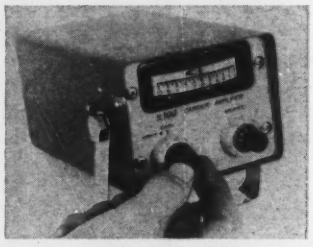
ANGLE INDICATOR



New Precise Angle Indicator displays in digital readout angular displacement from synchro transmitter. Standard accuracy is ±6 minutes max; repeatability is ±1 minute; readability is 0.5 minute; slewing speed is 25°/sec nominal.—*Clifton Precision Products Co., Inc.,* 5050 *State Rd., Drexel Hill, Pa.*

CIRCLE 286 ON READER-SERVICE CARD

MINI CARRIER AMPLIFIER



New transistorized single-channel phase-sensitive Carrier Amplifier is for two frequencies, 3 and 10 kc, with line regulation of better than 0.1% and temperature coefficient of less than 0.01%/°F. Provides carrier frequency, regulated to within 1%, for a-c transducers. Ten-turn precision potentiometer forms one-half of a bridge circuit when a two-element senor is employed.—*Crescent Engineering & Research Co.,* 5440 *North Peck Rd., El Monte, Calif.*

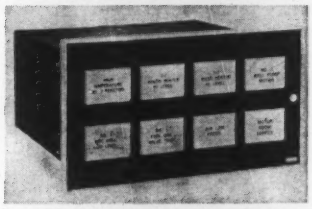
CIRCLE 287 ON READER-SERVICE CARD

TELEMETRY COMMUTATOR

New Datacel Type 100 Telemetry Commutator features extremely low contact noise and extraordinarily long life. 90-channel unit offers sampling rates as high as 1350/sec with standard sampling speeds of 1, 2, 5, 10 and 15 rps. Uses patented diaphragm-type Capcel contact. Operates from 28 vdc /115 v/400 cps or 115 v/60 cps.—*Datametrics, Inc.,* 87 *Beaver St., Waltham* 54, *Mass.*

CIRCLE 288 ON READER-SERVICE CARD

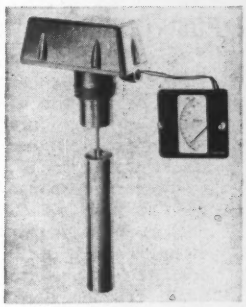
SOLID STATE ANNUNCIATOR



New Model 361 miniaturized solid-state Annunciator has each circuit, including the lamps and light box, contained in a single channel-mounted module which is plugged into cabinets. Automatic reset or manual reset to "normal" available after acknowledgement of alarm.—*Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.*

CIRCLE 289 ON READER-SERVICE CARD

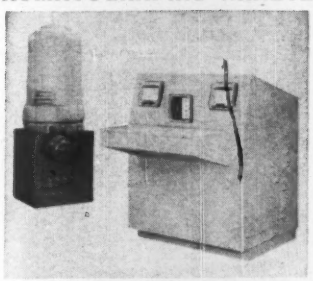
LIQUID LEVEL TRANSDUCER



New Liquid-level Transducer permits indication and monitoring of level, temperature and pressure on the same Omniguard monitoring instruments. Detector employs frictionless magnetic coupling to transmit motion from level change to contact wiper movement. Sensing is by a range displacer with Ni-Span-C extension spring.—*Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.*

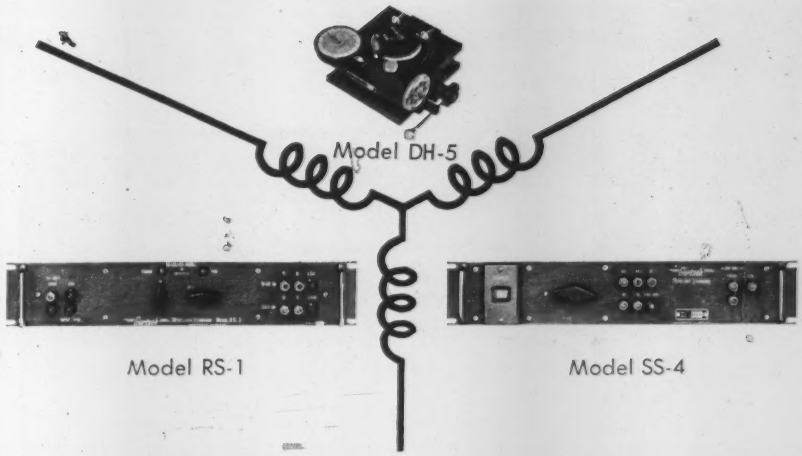
CIRCLE 290 ON READER-SERVICE CARD

CHROMATOGRAPHIC ANALYZER



New Chromatographic Analyzer measures up to six components for control of process stream composition, monitors continuous measurement trends by two pneumatic recorders. Sharp peak definition has been achieved through unique sampling valve which delivers a uniform slug of sample gas to column for each analysis. All timing functions are initiated by metal belt in programmer driven by a synchronous motor.—*Bulletin.—Foxboro Co., Foxboro, Mass.*

CIRCLE 291 ON READER-SERVICE CARD



now...high accuracy synchro and resolver testing

—GERTSCH STANDARDS REPLACE COSTLY ELECTRO-MECHANICAL METHODS

Gertsch Synchro Standards simulate the output of a master Synchro Transmitter (CX), with better than 2 seconds of arc accuracy. Ideal for checking Synchro Control Transformers (CTs), or complete systems. Units feature a low effective unbalance impedance which permits loading the output without introducing stator output errors.

When driven by a suitable signal source, unit provides stator outputs S_1, S_2 and S_3, corresponding to the outputs of a master Synchro Transmitter as the shaft is rotated in 5° increments. Quadrant switching simulates operation over a full 360°. Series SS.

Gertsch Resolver Standards simulate the output of a master Resolver Transmitter (RX). Checks Resolver Control Transformer (RCT). Unit features low effective unbalance impedance, hence negligible loading error.

Driven by a suitable signal source, unit produces 2 isolated output voltages corresponding to the sine and cosine output voltages of a master Resolver Transmitter as the shaft is rotated in 5° increments. Full 360° operation. Series RS.

Synchro and Resolver Standards rotate throughout a full 360°, in 5° increments. Accuracy is better than 2 seconds of arc. Both single-switch and 2-switch models are available to cover all standard voltages and frequencies. Bulletins SS and RS on request.

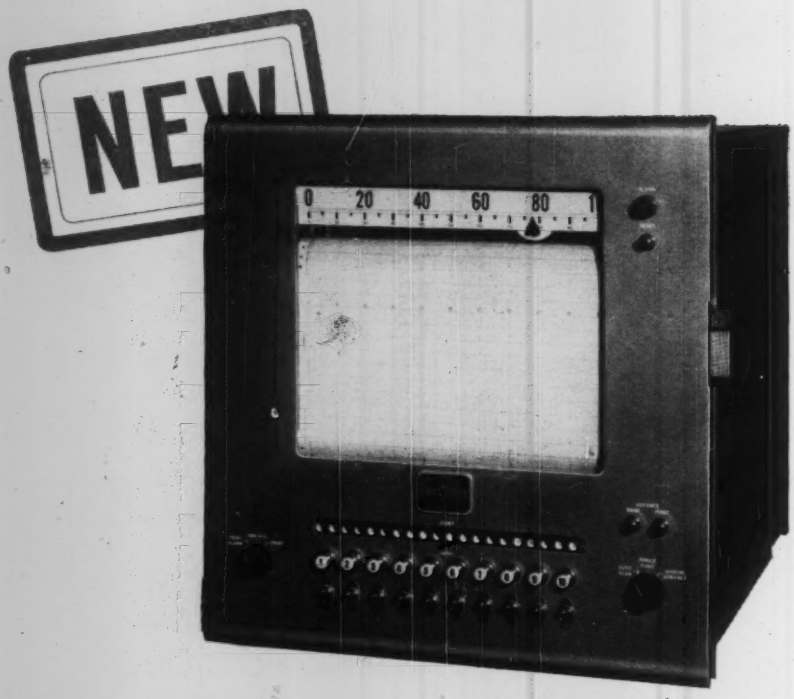
Gertsch Divider Heads—for checking angular measurements on all types of rotary components. Accuracy is ±15 seconds. Repeatability: ±5 seconds. Large dial indicator provides direct readings with 3-second resolution. Unit rotates in 5° steps through a full 360° in either direction . . . is quickly set up, easy to operate, and fully portable. Bulletin DH-5.

Gertsch

GERTSCH PRODUCTS, Inc.,

3211 South La Cienega Boulevard, Los Angeles 16, California / UPton 0-2761 – VErmont 9-2201

CIRCLE 115 ON READER-SERVICE CARD



New point-a-second alarm scanner

scans or records up to 200 variables to detect off-normal conditions fast

The Dynamaster® Alarm Scanner combines high-speed scanning of any type of variable, continuous or off-normal recording, and multiple-alarm settings in a single monitoring instrument.

Check these Dynamaster capabilities against your alarm scanning requirements:

Positive alarm notification, provided simultaneously by:

(1) illuminating a red "alarm lamp" on instrument case

(2) energizing external visible and audible alarm signals

(3) automatic print-out of measured value and identification of the off-normal variable.

Alarm flexibility. Up to 20 individually adjustable potentiometers can be provided—permitting separate high and low settings for each of 10 variable groups.

Simplified operation. Any high- or low-alarm limit can be changed within 5 seconds. All operator selector switches are mounted on face of instrument. Scan cycle is traced by lamps on front of Scanner case.

Long instrument life is insured by transistorized design and precision mechanical construction. To prevent unnecessary wear, Dynamaster servo-balancing mechanism remains inoperative during scanning until an alarm condition is detected.

For complete details on these and other features of the new Dynamaster Alarm Scanner, write to: 1.19

THE BRISTOL COMPANY

Waterbury 20, Connecticut

Or nearest Bristol Branch Office

BRISTOL'S

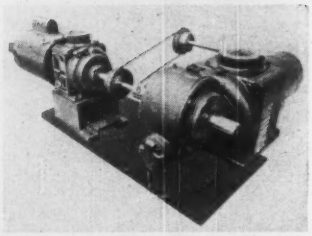
THE DATA-MASTER CORPORATION

Subsidiary of The Bristol Company, Waterbury 20, Conn.

ACCO

CIRCLE 116 ON READER-SERVICE CARD

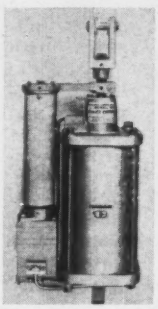
SPEED CONTROL



New infinitely-variable closed-loop Speed Control System holds exact speed under widely varying load conditions. Utilizes small differential with Graham speed reference and load transmission and provides input to differential. When speeds do not match, differential output adjusts speed setting of driver transmission. —*Graham Transmissions Inc., Menomonee Falls, Wis.*

CIRCLE 292 ON READER-SERVICE CARD

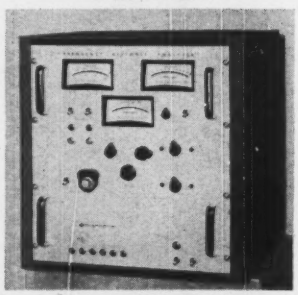
VALVE POSITIONER



New pneumatic Valve Positioner develops 1,200 lb of thrust, weighs only 30 lb, has 2 sec stroking time for 5". Frequency response with no load at 10% peak-to-peak input signal, change is 1.0 cps. At 5% peak to peak, frequency response is 0.5 cps. Accuracy is 1.0% full stroke—*Hagan Chemicals & Controls, Inc., Controls Div., Hagan Center, Pittsburgh 30, Pa.*

CIRCLE 293 ON READER-SERVICE CARD

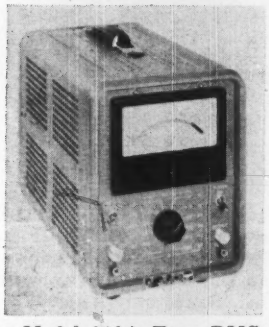
FREQUENCY RESPONSE ANALYZER



New Model 100 Frequency Response Analyzer measures amplitudes, amplitude ratios, and phase relationship of two input signals from ½ to 600 cps, generates sinusoidal signal. Log frequency, amplitude ratio in db, and phase are indicated on panel. Input for both channels is 2 megohms, input signal levels are from 10 mv to 30 v. Accuracies are 2% frequency, 3° phase, and 0.4 db amplitude ratio.—*Industrial Measurements Corp., 250 N. Thomas St., Pomona, Calif.*

CIRCLE 294 ON READER-SERVICE CARD

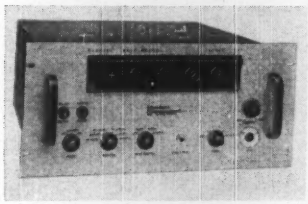
TRUE RMS VOLTMETER



New Model 910A True RMS Voltmeter provides 1% midband accuracy, 10 cps to 7 mc bandwidth, 100 μv maximum sensitivity; also features high input impedance, high sensitivity, and fast response.—*John Fluke Mfg. Co., Inc., Box 7428, Seattle 33, Wash.*

CIRCLE 295 ON READER-SERVICE CARD

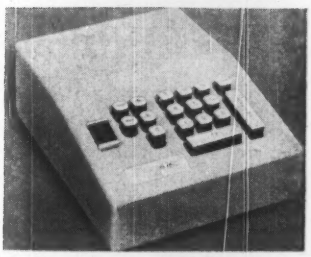
DIGITAL MULTIPLE METER



New solid-state Eitronic 851 is a four-digit multiple meter for d-c ratios, a-c volts, and resistance. Specifications include: ±0.0001 to ±999.9 dc voltage and d-c ratio ranges, 0.0001 to 999.9 a-c voltage range.—*Electro Instruments, Inc., 8611 Balboa Ave., San Diego 11, Calif.*

CIRCLE 296 ON READER-SERVICE CARD

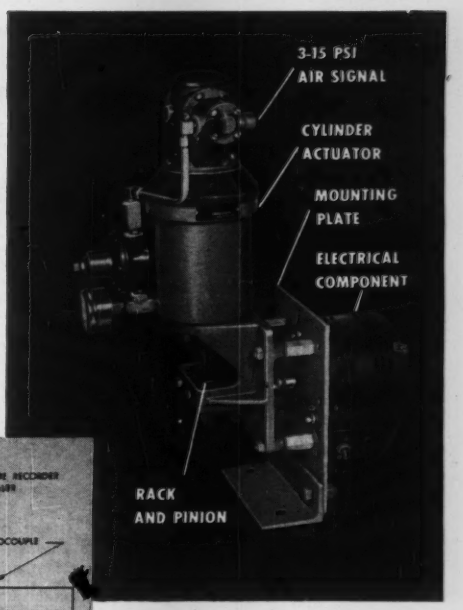
NUMERIC KEYBOARD

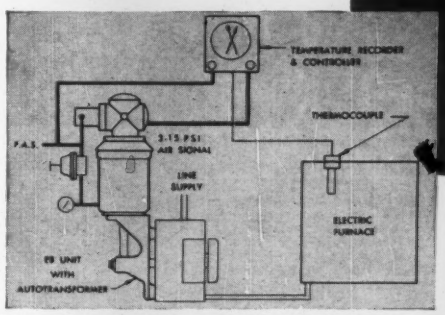


New K-110 Numeric Keyboard in line of photoelectric-encoding peripheral data processing devices permits generation of any standard or special 5-, 6-, 7- or 8-bit binary code. 10-data channels are available for any combination of binary-code signals, and signals for strobe, dual logic, tab, shift, etc. Features are extremely-high reliability and cost reduction through complete elimination of electrical and mechanical encoding matrices, contacts and switches.—*Invac Corp., 14 Huron Dr., Natick, Mass.*

CIRCLE 297 ON READER-SERVICE CARD

REGULATE
VOLTAGE,
CURRENT,
RESISTANCE,
INDUCTANCE,
or
CAPACITANCE





Quality control in heat treating and other exacting temperature control applications is vastly improved by using a Conoflow Model EB with a variable autotransformer.

AUTOMATICALLY-PNEUMATICALLY
CONOFLOW MODEL EB
CURRENT CONTROLLER

The Model EB is a unique final control element—a Conoflow exclusive. Essentially, it is a pneumatic-electric transducer, consisting of a cylinder actuator, a rack and pinion mechanism, and an electrical component such as a rheostat, autotransformer or potentiometer. The cylinder receives a 3-15 psi instrument signal and produces a rotary motion (to 360°) which precisely positions the electrical device, affording automatic control of any electrical value.

Model EB Current Controllers are available from Conoflow in over 200 different combinations of electrical components. These assemblies are designed to handle a wide variety of control applications more efficiently and more economically than possible by manual operation. A few are:

- CONSTANT PRESSURE
- PROPORTIONAL FLOW
- LIQUID LEVEL
- MACHINE TOOL SPEED
- CONVEYOR CONTROL
- HEAT TREATING
- CONSTANT TEMPERATURE
- BOILER FEED WATER CONTROL
- REWIND CONTROL
- CONSTANT FLOW
- STOKER FEED CONTROL
- HUMIDITY CONTROL

For additional information on the Model EB Current Controller, write to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. Ask for Bulletin EB-3.

CONOFLOW CORPORATION
FOREMOST IN FINAL CONTROL ELEMENTS
SUBSIDIARY WALWORTH

CIRCLE 117 ON READER-SERVICE CARD

HIGH VOLTAGE QUALITY RELIABILITY

POWER SUPPLIES

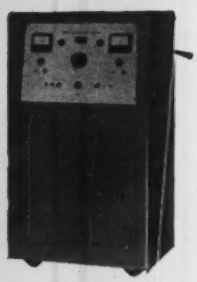
Standard power supplies and transformers available from stock. Others built to your specific requirements from stock components.

WRITE FOR COMPLETE SPECIFICATIONS

120 KV DC AT 5 MA

- Zero Start
- Reversible Polarity
- Input 115V-60 cycle
- Safety Interlock
- Electronic overload circuits provide full range protection
- Automatic stored energy discharge switch
- No exposed high voltage components

Completely instrumented supplies available from 1 KV to 300 KV DC and up to 50 KW.



Model PSC 120-5-2

30 KV DC AT 5 MA OR 35 KV DC AT 1 MA

- Completely Self-Contained—Portable
- Ideal as Insulation Test Set and "Hi-Pot" TESTER
- No Exposed High Voltage Components
- Electronic overload circuits settable from 0-120% of rated current and voltage
- Units from 2.5 KV up to 60 KV available
- Many other features

Model PSC 30-5-1

DEL ELECTRONICS CORPORATION

321 HOMESTEAD AVENUE • MOUNT VERNON, N. Y. • OWENS 9-2000

CIRCLE 118 ON READER-SERVICE CARD

NANMAC CORPORATION

is proud to introduce the . . .

"PLASTIC THERMOCOUPLE"

The body of the Model "P" thermocouple can be fabricated from any plastic, plastic-mineral composites, non-metal, alloy, or special proprietary material. Thus surface or in-wall temperatures of a wide variety of materials can be measured accurately without disturbing the normal heat distribution pattern caused by differences in thermal properties. Examples of materials successfully used in the Model "P" include: plexiglass, asbestos phenolics, graphite, copper, molybdenum and special proprietary plastics.

MODEL-P

FEATURES

- √ Response time—less than 10 microseconds to transient temperatures.
- √ Thermal junction maintained even during erosion.
- √ Temperature range from —320° F to over 5000° F.
- √ Pressure range to over 5000 PSL.
- √ Two-dimensional thermal junction for accurate location of point of measurement.
- √ Thermocouple constructed of flat ribbon wires and mica insulation.

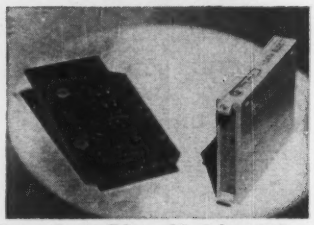
NANMAC CORPORATION

P.O. BOX 8 INDIAN HEAD, MARYLAND

WRITE FOR BULLETIN TB161

CIRCLE 119 ON READER-SERVICE CARD

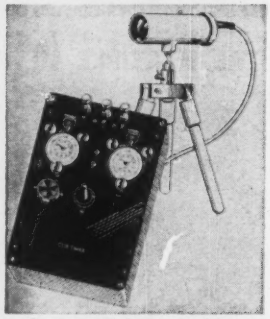
LOGIC MODULE



New Data-Bloc Model 1012 and Data-Pac Model 2012 10-megacycle flip-flop Logic Module are electrically identical. Basic circuit module contains three gate circuits and a flip flop, which is capable of being set, cleared and complemented at 10-Mc rate.—*Harvey-Wells Electronics, Inc., 14 Huron Dr., Natick, Mass.*

CIRCLE 298 ON READER-SERVICE CARD

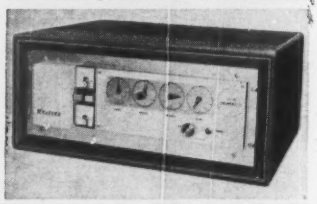
PHOTOELECTRIC TIMER



New Super Cub portable transistorized electric stop-watch Actuator for accurate timing of sports events and industrial operations actuates two stopwatches simultaneously with only a 20-msec delay. Works by interrupting a light source or by making and breaking electrical contacts. —*Heuer Timer Corp., 441 Lexington Ave., New York 17, N. Y.*

CIRCLE 299 ON READER-SERVICE CARD

TIME-FREQUENCY STANDARDS



New Models TS-10 and TS-11 Chronometers provide either 30- or 100-watt outputs at 50 or 60 cps, and low-level outputs at 300 and 1500 cps to supply master power to recorders, time indicators, or programmed operations at frequencies accurate to better than one part in 10,000,000. Utilize high-Q tuning fork, temperature-compensated and immune to atmospheric pressure and temperature variations. Bulletin.—*Westrex Communication Systems Div. of Litton Systems, 540 W. 58 St., New York 19, N. Y.*

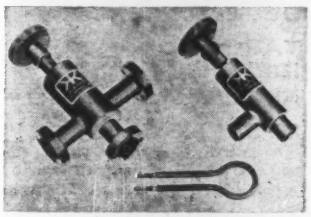
CIRCLE 300 ON READER-SERVICE CARD

POSITION CONTROLLER

New PF-11 low-cost ruggedized Sensor and MR-61 remote meter-type Indicator give position of butterfly valves, dampers, etc. Sensor is available with one or two potentiometers and/or limit switches for control functions. Meter has integral circuit board, is available for panel mounting or in NEMA 1 or explosion-proof enclosure. Model MT-61 Metertrol combines push button control for applications requiring both remote control and indication. Data Sheets J217 and J218.—*Jordan Controls, Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.*

CIRCLE 301 ON READER-SERVICE CARD

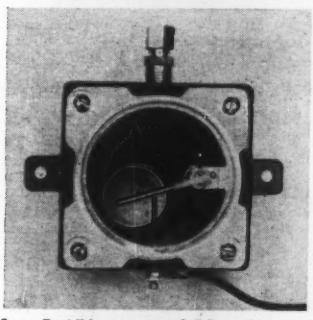
HIGH-VACUUM VALVES



New stainless-steel 1" Valves operate at 10^{-10} mm Hg pressure, are made as right-angle and cross types. Closure is made by forcing a modified knife edge into soft low-vapor-pressure Indium-alloy seat.—*Kane Engineering Labs., 845 Commercial St., Palo Alto, Calif.*

CIRCLE 302 ON READER-SERVICE CARD

SAFETY SWITCH



New L-150 patented Murphy water-level Switchgage for engines shows level and condition of water and shuts down engine automatically when water reaches dangerous low level. Visible float and pointer-contacts show operating condition of the safety-switch at all times. Rated at 50 psi.—*Frank W. Murphy Mfg. Inc., 3131 S. Sheridan Rd., Tulsa, Okla.*

CIRCLE 303 ON READER-SERVICE CARD

STANDARD and SPECIAL manual and motor-driven ROTARY SWITCHES

ELECTRO SWITCH CORP. designs, manufactures, and tests standard and special rotary switches for the most complex electric and electronic circuits. The standard switch types range from 2 to 16 positions and from 0.5 to 200 amperes.

Special rotary switches are assembled from standard parts and, if necessary, to meet MIL specifications.

Please write for latest catalog of manually operated rotary switches or for the catalog of ammeter, voltmeter, and other instrument switches.

SLIP-RING DIVISION of *Electro Switch Corp.* designs, manufactures, and tests slip-ring, brush-holder, and rotary-switch assemblies to satisfy any performance requirements, applicable MIL specifications, and most severe environmental conditions. Slip-ring types of assemblies provide reliable means for carrying electric signals between stationary and rotating elements of a system. Pancake and internal or external drum styles can be constructed.

Rotary switches provide high-speed multi-circuit switching with a-c or d-c motor drives. High-precision commutator segments range from subminiature dry-circuit sizes to heavy-duty power-handling sizes.

Please write for Bulletin 60-01 describing slip-ring and motor-driven rotary switches.

ESCO of WEYMOUTH

ELECTRO SWITCH CORP.

Weymouth (Boston 88), Massachusetts

CIRCLE 120 ON READER-SERVICE CARD

HASTINGS DIFFERENTIAL PRESSURE INDICATOR

(An Electrical dp Gauge for Air and Gases)

CHOICE of 10 RANGES

.01" H_2O through 100" H_2O Full Scale

The Hastings Differential Pressure Indicator is composed of an indicator with power source unit and a dp tube. The indicator unit is available as shown or panel mounted, water proof and explosion proof housed and as control, alarm and recorder installations. The meter can be remotely located if desired.

The dp tube incorporates the patented Hastings compensated heated thermopile element which measures differential pressure directly in inches of water.

The Hastings Differential Pressure Indicator offers the following superior features:

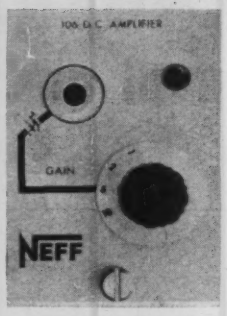
- **Extremely sensitive to low pressure differentials**
- **Rapid Response Time—less than ½ second**
- **Suitable for corrosive gases—Noble metal thermopile and nickel plated dp tube**
- **Versatile—Indicate, control, record—Remote**
- **Electrical rather than mechanical**
- **Readability from .0001" H_2O thru 100" H_2O**
- **Inexpensive—Less than most transmitter-type gauges**
- **Variety of Applications—Draft Gauge—Pressurized Enclosures—Mass Flowmeter—Process Control—Air Gauging—Leak Testing—Porosity Testing—Null Balance**

Write or call for detailed specifications or for information on Hastings complete line of Vacuum, Pressure, and Flow Measuring Instruments.

HASTINGS-RAYDIST, Inc.
Hampton, Virginia PArk 3-6531

CIRCLE 121 ON READER-SERVICE CARD

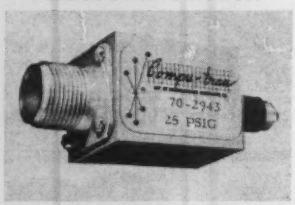
AMPLIFIER



New Type 106 single-ended solid-state D-c Amplifier is particularly applicable as line driver or for driving high frequency galvanometers from output of high-impedance sources such as those associated with FM magnetic-tape recording systems. Frequency response is 10 Kc. Fixed gain steps of 1, 2, 5, and 10 with separate vernier control permits gain selection over range of 1:20. ¼-ohm output impedance is for monitoring or line driver applications; another output for driving high-frequency galvanometers is taken from a plug-in galvanometer damping network internal to the amplifier.—*Neff Instrument Corp.*, 1088 *E. Hamilton Rd., Duarte, Calif.*

CIRCLE 304 ON READER-SERVICE CARD

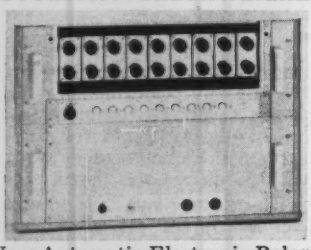
PRESSURE SWITCH



New Compu-tran® Pressure Switch provides on-off control at predetermined pressure, with operating range 0.5 to 3000 psig. Incorporates diaphragm as sensing element and miniature snap-action switch as actuating element, with electrical rating of 5 amp (SPDT—NO or NC). Repeatability is 1% to 2%.—*International Resistance Co., Control Components Div.*, 401 *N. Broad St., Phila.* 8, *Pa.*

CIRCLE 305 ON READER-SERVICE CARD

AUTOMATIC CHECKWEIGHER



New Automatic Electronic Balances weigh low-weight range objects such as cigarettes, mechanical parts, electronic components, etc. Seven different models available in from one-to-1000-gram capacities. Sensitivity is 0.05%; weighing speed up to 10,000/hrs.—*Mettler Instrument Corp., Box 100, Princeton, N. J.*

CIRCLE 306 ON READER-SERVICE CARD

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

RADIO PHYSICS and ASTRONOMY

RE-ENTRY PHYSICS

PENETRATION AIDS DEVELOPMENT

TARGET IDENTIFICATION RESEARCH

SYSTEMS:
Space Surveillance
Strategic Communications
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SYSTEM ANALYSIS

COMMUNICATIONS:
Techniques
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Theory

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• *A more complete description of the Laboratory's work will be sent to you upon request.*

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
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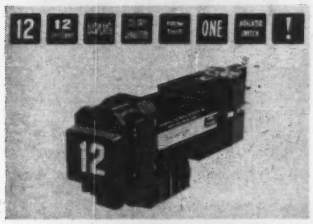
LEXINGTON 73, MASSACHUSETTS

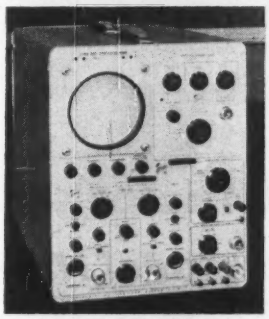
INDICATOR SWITCH



New "Cue" Indicator Switch contains built-in miniature readout unit with twelve-display capacity. Visual display is on 1" square push-button face.—*Industrial Electronic Engineers, Inc.*, 5528 *Vineland Ave., North Hollywood, Calif.*

CIRCLE 307 ON READER-SERVICE CARD

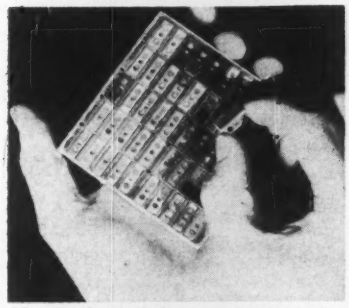
DUAL-TRACE OSCILLOSCOPE



New Type 661 Oscilloscope is a complete pulse-sampling system with rise-time of 0.35 nanosec featuring capabilities for triggering externally, or internally on either A or B trace, ability to show Lissajous patterns on the 5" CRT, to expand the signal over 100 times verticallly and horizontally, and to drive X-Y plotters or similar readout accessories.—*Tektronix, Inc., Box* 500, *Beaverton, Ore.*

CIRCLE 308 ON READER-SERVICE CARD

MINI DIGITAL COMPUTER



New microminiature Digital Computer utilizing Solid Circuit® semiconductor networks has only 6.3-cu-in volume, weighs 10 oz, yet provides identical electrical functions of a computer with conventional components 150-times its size and 48-times its weight. It uses 587 digital circuits, each formed within a minute silicon bar. Details in bulletin.—*Texas Instruments, Inc., Box* 5474, *Dallas* 22, *Tex.*

CIRCLE 309 ON READER-SERVICE CARD

THIS ADVERTISEMENT IS NEITHER AN OFFER TO SELL NOR A SOLICITATION OF OFFERS TO BUY ANY OF THESE SECURITIES. THE OFFERINGS ARE MADE ONLY BY THE PROSPECTUS.

NOVEMBER 21, 1961

411,429 SHARES CAPITAL STOCK
(WITHOUT PAR VALUE)

ASTRODATA, INC.

NEW ISSUE

100,000 SHARES CAPITAL STOCK

PRICE $10 PER SHARE

NOT A NEW ISSUE

311,429 SHARES CAPITAL STOCK

These shares are being offered by Epsco, Incorporated to holders of its Common Stock for subscription at the rate of one share of Astrodata, Inc. Capital Stock for each two shares of Epsco, Incorporated Common Stock held of record on November 16, 1961. The Subscription Offer will expire at 3:00 P.M., Eastern Standard Time, on December 4, 1961. During the subscription period the underwriters may offer shares of Astrodata, Inc. Capital Stock as more fully set forth in the Prospectus.

SUBSCRIPTION PRICE $9 PER SHARE

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GRANBERY, MARACHE & CO. WILLIAM R. STAATS & CO.

CIRCLE 122 ON READER-SERVICE CARD

Ultra-fast Optics
for
INFRA-RED
Instrumentation

Reflective Optics
Cassegrain Systems
Paraboloids to f/.3
Off-axis mirrors
Refractive Optics
Si and Ge Optics
IR Windows
Aspherics
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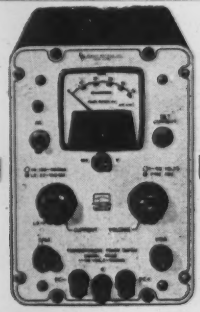
John Unertl Optical Co.
3551-55 East St.
Pittsburgh 14, Pa.

CIRCLE 123 ON READER-SERVICE CARD



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for
REGULATED
POWER SUPPLIES

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WESTBURY, L. I., N. Y.
EDgewood 3-6200 Area Code 516

CIRCLE 124 ON READER-SERVICE CARD

a wide range of advanced

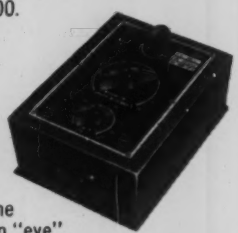
INSTRUMENTS AND CELLS FOR MONITORING OF ULTRA-PURE WATER

NEW

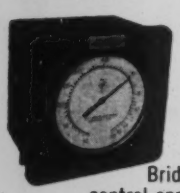
TYPE RA-4 DIRECT-READING SOLU METER

Utilizes a non-bridge type of measuring circuit to supply direct meter display of solution conductivity. Provides stabilized 0-10mv DC output for remote operation of a standard potentiometer recorder. Portable or panel mounting. Range: 0-1 micromhos/cm. spec. cond. $182.00.

TYPE RD SOLU BRIDGE



Provides simple manual balancing. Uses AC Wheatstone Bridge and electron "eye" tube as null indicator. Range: 1-18 megohm-cm. spec. res. $78.00.



TYPE RI INDICATOR-CONTROLLER

Features self-balancing, continuously indicating AC Wheatstone Bridge for measurement and control applications where a record is not required. Range: 1-18 megohm-cm. spec. res. $331.00.

RECORDER CONTROLLERS

All types of recording instruments available for this service.

CONDUCTIVITY CELLS AND TEMPERATURE COMPENSATORS

Complete range of cells and compensators for ultra-pure water service. Automatic or manual temperature compensation available.

Write today for complete technical details.

Industrial Instruments Inc.

89 Commerce Road, Cedar Grove, Essex County, N. J.

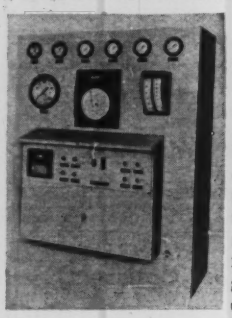
CIRCLE 125 ON READER-SERVICE CARD

PORTABLE THEODOLITE

New portable Aiming Theodolite quickly establishes and corrects azimuth heading of Pershing missle that is transported on and can be fired directly from a special tracked vehicle or can be carried by helicopter or fixed wing aircraft. System built around a north-seeking gyroscope employs 6400-part mil-circle type of scale.—*Perkin-Elmer Corp., Electro-Optical Div., Norwalk, Conn.*

CIRCLE 310 ON READER-SERVICE CARD

COMBUSTION CONTROL SYSTEM



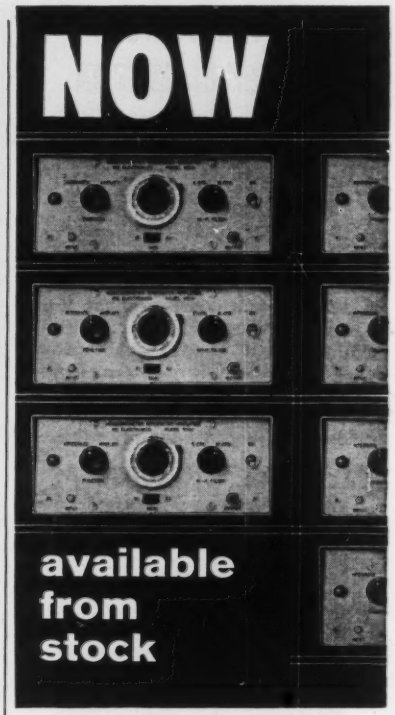
New packaged Combustion Control System for register gas and/or oil burner includes flame-failure protection, programming equipment, pressure gages, and complete control valving and piping.—*Reliance Instrument Div., Electro-Mech Corp., 500 Livingston St., Norwood, N. J.*

CIRCLE 311 ON READER-SERVICE CARD

SHIELDED LVDT

New "E" line low-cost linear variable Differential Transformers (LVDT's) electromechanically transduces minute linear displacements into electrical signals. Magnetically and electrostatically shielded, impregnated and sealed in stainless-steel housings, they have infinite resolution. Stock models (E100D, E200D, and E300D) have linear range from ±0.100" to ±0.300" with ±1% linearity over specified range. —*Schaevitz Engineering, Route 130 and Schaevitz Blvd., Pennsauken, N. J.*

CIRCLE 312 ON READER-SERVICE CARD



MB model N504 INTEGRATOR AMPLIFIER

- Measure acceleration, velocity, or displacement with conventional accelerometers and vibration meters.
- Measure acceleration or velocity from accelerometer input with standard voltmeters.
- Convert accelerometer signals to velocity for automatic control of vibration exciter displacement, velocity or acceleration.
- Eliminate need for cathode follower and power supply.

SPECIFICATIONS

Frequency Response:	**Amplify Position** (5 cps filter) 10–10,000 cps ± 2% 5–10,000 cps ±7% **Integrate Position** (–6 db/octave) 10–2,000 cps ± 5% 5–2,000 cps ±10%
Sensitivity:	**Amplify Position** Maximum gain = 100 **Integrate Position** 1 mv(rms)/"g" peak converted to 96.3 mv (rms)/in./sec.(rms)
Input Impedance:	Greater than 200 megohms
Output Impedance:	Less than 600 ohms

Complete technical details in Bulletin 131. Write...

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC.
1103 State Street, New Haven 11, Conn.

CIRCLE 126 ON READER-SERVICE CARD

Pressure: to 540 psi.

Ten orifice sizes: 3/64" through 1/4".

Wide voltage range: standard with 115V. AC.; also 12, 24, 208, 230, 460V. AC. 50/60 cycle.

Body: brass bar stock or 18-8 stainless steel. All moving parts, stainless. Seat disc, synthetic rubber. Sizes, 1/8" and 1/4" NPT. Both conduit and grommet types.

Underwriters' listed a safety valve

Yes, "Master-mite" is the mighty mite of solenoid valves. Useable on a wide range of media including hydrogen, acetylene, etc. Works right in any position. Small, but with extra strength in the Marsh manner. Coils never overheat. Leak tight. Remarkably quiet.

Ask for special bulletin

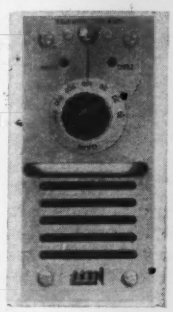
MARSH INSTRUMENT COMPANY
Division of Colorado Oil & Gas Corporation
Dept. 42, Skokie, Ill. Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas. Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N. J.

MARSH

GAUGES • THERMOMETERS
VALVES

CIRCLE 127 ON READER-SERVICE CARD

DIFF D-C AMPLIFIER



New Type 101B solid state Differential DC Amplifier is for low-level signals in the 0-100-cps frequency range. Circuitry features input impedance greater than 1 megohm, constant under all conditions of source impedance and gain setting; output impedance of less than ½ ohm; slewing rate of 5000 v/sec.—*Neff Instrument Corp., 1088 E. Hamilton Rd., Duarte, Calif.*

CIRCLE 313 ON READER-SERVICE CARD

GAMMA ANALYZER

New Model GSS-1B is said to be the only Gamma Analyzer that operates automatically without adjustment to scan, record and analyze emitters having energies varying from 0.003 kev to 3 mev. System provides complete spectral analysis with good resolution in short time. Range is 0.1 kev to 6 mev.—*Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.*

CIRCLE 314 ON READER-SERVICE CARD

OPERATIONS RECORDER

New Panastat Thor VII solid-state high-speed sequential-event Recording Annunciator monitors variables in continuous processes and power plants. Alarm points going off-normal or returning to normal are printed in time sequence even if only one msec apart. System can be checked out quickly.—*Panellit Div. Information Systems, Inc., Skokie, Ill.*

CIRCLE 315 ON READER-SERVICE CARD

LepeL

High Frequency

INDUCTION HEATING UNITS

Lepel induction heating equipment is the most practical and efficient source of heat developed for numerous industrial applications

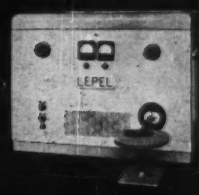
LEPEL ELECTRONIC TUBE GENERATORS

STANDARD UNITS
Frequencies: 180 Kc to 600 Kc
Sizes: 1 Kw to 100 Kw output

MEGACYCLE UNITS
Frequencies: 3 Mc to 50 Mc
Sizes: 2½ Kw to 20 Kw output

DUAL FREQUENCY UNITS
Sizes: 5 Kw, 10 Kw & 20 Kw output

LEPEL SPARK GAP CONVERTERS
Frequencies: 400 Kc to 900 Kc
Sizes: 2 Kw to 30 Kw input



BRAZING
SOLDERING
HARDENING
ANNEALING
MELTING
BOMBARDING
ZONE REFINING
CRYSTAL GROWING
PLASMA TORCH

LEPEL LABORATORY SERVICE
Lepel maintains a fully equipped laboratory where experienced induction heating engineers will process your work samples and submit complete laboratory reports and recommendations without any obligation.

WRITE FOR NEW LEPEL CATALOG

LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.
CHICAGO OFFICE: 6246 WEST NORTH AVE.

CIRCLE 128 ON READER-SERVICE CARD

NEW IBM DEVELOPMENTS IN PROCESS CONTROL

create unusual opportunities

Men who join us now can play a fundamental role in the automation of industrial processes in the future. Important breakthroughs in the application of digital data processing techniques to the automatic control of industrial processes are creating new career opportunities.

There are new openings at IBM for engineers, scientists and mathematicians with operating and supervisory experience in these process industries: chemicals, glass, metals, paper, petroleum, public utilities, and rubber.

Your background should include experience in at least two of the following areas:

- Process design
- Control engineering
- Instrumentation
- Operations research
- Data Handling and data processing
- Economic analysis

You will have the opportunity to work with a wide variety of management and industrial personnel. Successful candidates will receive specialized training in the application of computers to process control.

Positions are available throughout the Eastern United States.

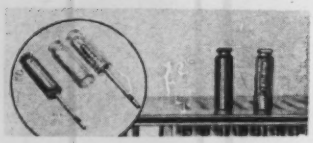
For details, please write, outlining your background and experience. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Mr. J. W. Nipps, Dept. 569M
IBM Corporation
425 Park Avenue
New York 22, N.Y.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

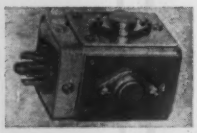
PLASTIC DIODE HOLDERS



New clear plastic Diode Holders permit identification of color codes, or type markings allow personnel to see component that is soldered in the holder and thus select desired type for insertion in matrix of Sealectoboard programming system.—*Sealectro Corp.*, 139 *Hoyt St., Mamaroneck, N. Y.*

CIRCLE 316 ON READER-SERVICE CARD

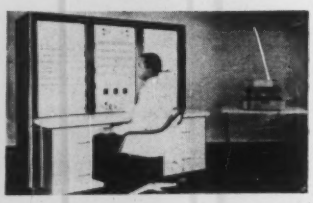
SERVO SYSTEMS



New Solar Model 6102 Solid State Servo Amplifier with reversible nonsynchronous motor from Servo system which has plug-in features, is completely transistorized, has two d-c signal inputs and one a-c input, provides to 80 in-lb in response to control signals of less than one millivolt. Sensitivity is one millivolt d-c or 60 cps. Bulletin 107.—*Solar Electronics Co.*, 5909 *Melrose Ave., Hollywood* 38, *Calif.*

CIRCLE 317 ON READER-SERVICE CARD

GP COMPUTER



New solid-state modular Digital Data Processor (DDP) is a standard medium-size computer for including real-time simulation, control of high-speed target precision tracking, and real-time test data acquisition. It has a 19-to-25 bit range, sufficient speed and input-output flexibility. Single-address parallel binary stored-program machine utilizes a 5-μsec 4- or 8-thousand-word core memory. Basic equipment is a high-speed paper tape input (500 to 1,000 characters/sec) and Flexowriter output.—*Computer Control Co., Inc.*, 2251 *Barry Ave., Los Angeles* 64, *Calif.*

CIRCLE 318 ON READER-SERVICE CARD

PHASE-LOCK DISCRIMINATOR

New Model 0447 Phase-Lock Discriminator utilizes phase-coherent detection. Tracking loop and output filter parameters are closely controlled

SALES REPRESENTATIVE

OSCILLOGRAPHIC & RELATED CHART RECORDING FIELD

GROWTH OPPORTUNITY

with dynamic major electronics manufacturer for man with 3 to 5 years experience in Oscillographic or related chart recording field. Base will be in New York City, with considerable national travel contacting original equipment manufacturers. Position involves application engineering, product sales and customer relations. College degree desirable but not essential.

Salary commensurate with experience
Our staff knows of this ad

Please send resume including salary requirements, to:

Box #388

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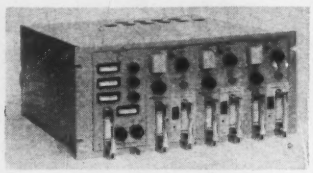
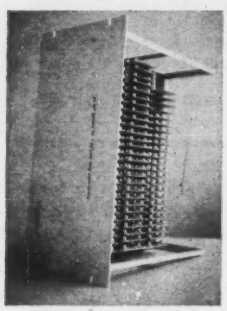


by a plugable selector.—*Hallamore Electronics Div., Siegler Corp.*, 714 *N. Brookhurst St., Anaheim, Calif.*

CIRCLE 319 ON READER-SERVICE CARD

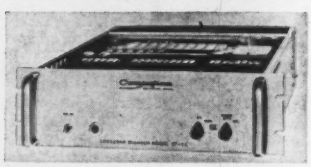
BINARY/BCD CONVERTERS



New direct binary-to-BCD Converters convert to 7-decade decimal output in 50 μsec. Based on parallel-conversion. 21, 19, 17, 13, 10 or 8 bits are standard.—*Wang Labs., Inc.*, 12 *Huron Dr., Natick, Mass.*

CIRCLE 320 ON READER-SERVICE CARD

CROSSBAR SCANNER



New ST-1-Series Standard Crossbar Scanner basically consists of a Type T crossbar switch with power supply, basic controls, and logic chassis containing the mercury-wetted relays. Units accommodate to 100 one-wire channels, 60 two-wire channels, or 40 three-wire channels.—*James Cunningham, Son & Co.*, 33 *Litchfield St., Rochester, N. Y.*

CIRCLE 321 ON READER-SERVICE CARD

THE MISSILE & SPACE VEHICLE DEPARTMENT

Announces

GROUP NOW FORMING

TO DEVELOP NEW PROGRAMS

FOR LARGE SCALE WEAPONS SYSTEMS

SIMULATION & MODELING

In-at-the beginning opportunities are available to engineers and scientists who can think in analogies and derive equations and functions from design data, customer requirements and specifications.

The new SIMULATION AND MODELING GROUP will develop new concepts and techniques for the simulation of advanced re-entry and recovery vehicle systems. Activities will involve the specification and application of analog and hybrid computing systems; preparation of programs for analysis and preliminary design efforts; extension of mathematical programs to integration of sub-systems hardware for testing and checkout.

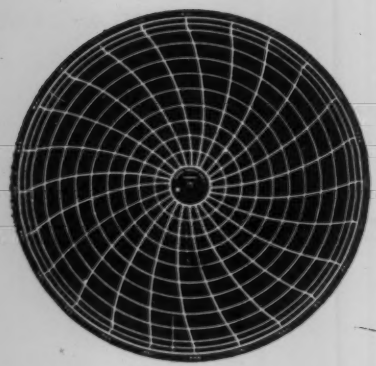
QUALIFICATIONS DESIRED: electrical engineering, engineering physics, aeronautical engineering or math degree; 3 or more years experience in analog simulation with some background in missile or RF fields preferred. Candidates should be familiar with mathematical aspects of systems engineering.

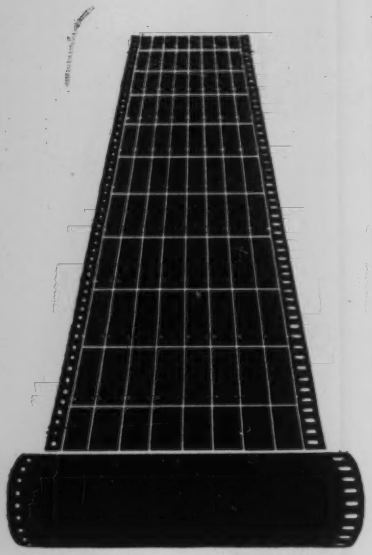
Members of this group will work in close collaboration with the MSVD engineers and scientists who contributed substantially to the FIRST recovery of a payload from outer space: the FIRST successful ablation re-entry over ICBM range and the FIRST recovery of complete re-entry vehicle over ICBM range as well as many other outstanding achievements in space technology.

Write in full professional confidence to:
Mr. Frank Wendt, Div. 500-L, Missile & Space Vehicle Dept.,
General Electric Co., 3198 Chestnut Street, Philadelphia, Pa.

All qualified applicants will continue to receive consideration for employment without regard to race, creed, color or national origin.

GENERAL ELECTRIC





INSTRUMENT CHARTS

Strip charts available in 3, 4 and 12 inch widths, circular charts in 8, 10 and 12 inch diameters. Made to resist expansion, shrinkage, humidity, dryness and heat. Close control of sizing gives clear record lines with minimum pen pressure. Charts are among the many thousands of accessories—all from a single dependable source—that can help your instruments perform at their very best.

Get details from your Honeywell field engineer, or write today for Catalog G100-6.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

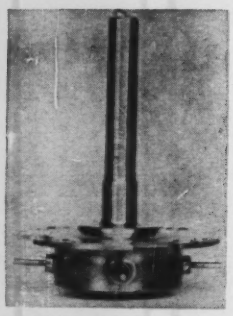
Honeywell

First in Control

SINCE 1885

CIRCLE 129 ON READER-SERVICE CARD

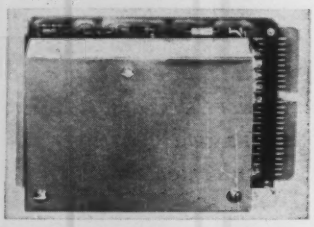
VERTICAL SENSING ELEMENT



New 218995-1 electromagnetic Vertical Sensing Element is a gravity-sensitive, liquid-damped pendulum device for any vertical sensing situation requiring an electrical output. Utilized in a servo system, it can initiate self-alignment of a gyro platform.—*Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.*

CIRCLE 322 ON READER-SERVICE CARD

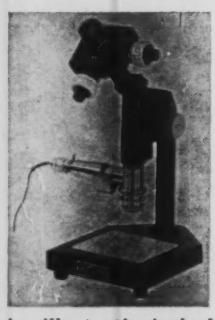
SERIAL MEMORY



New SM-40 digital Serial Memory with pulse delays ranging from 20 to 100 μsec at operating frequencies of 8 to 16 mc provides storage at "unprecedented input rates," as high as 16 bits/sec without need for carrier modulation. SM-40 uses new fused silica acoustic delay line with temp coefficient that approaches zero ($\pm$ 2 ppm/°C max); contains all necessary input-output logic, is compatible with H-PAc digital modules.—*Computer Control Co., Inc., 983 Concord St., Framingham, Mass.*

CIRCLE 323 ON READER-SERVICE CARD

SHOP MICROSCOPE



New inexpensive Shop Microscope consists of a plain stand with a rack and pinion slide that carries an inclined microscope tube with objective and ocular. Special accessories (shown in illustration) include an unusual coordinate measuring ocular and Ultropak illuminator.—*Opto-Metric Tools, Inc., 139 Varick St., New York 13, N. Y.*

CIRCLE 324 ON READER-SERVICE CARD

Richard B. Doorley, Mgr., New Products Div. Railway Maintenance Corp., Pittsburgh, Pa.

"Norbatrol helped us cut R&D time by 1 year with this Bistable Amplifier"

"Norbatrol's Bistable Amplifiers solved many control problems in redesigning our McWilliams Jack-and-Production Tamper from manual to reliable, automatic operation. Now this RMC railroad surface machine operates electronically—improves grade and cross level to accuracies never previously accomplished. And we got a bonus," Mr. Doorley continues, "these rugged, reliable static relays cost less than alternate systems."

You, too, can speed development and production time with the ultrasensitive Bistable Amplifier—it replaces mechanical relays in critical control and regulating applications. The Bistable incorporates silicon controlled rectifiers, magnetic amplifiers and attendant circuitry to give multiple inputs as low as 5 x 10^{-8} watts, fast response, high gain and a current output of 1 Amp at an 85° C. ambient.

GET THE FACTS on design and application data—write for technical bulletin CS60.

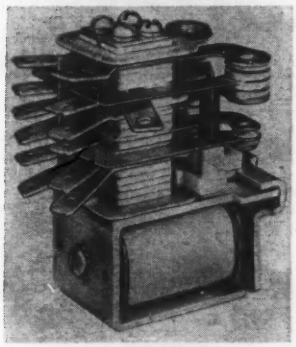
NE-1

NORBATROL Electronics Corp.

DEPT. D 356 Collins Avenue
Pittsburgh 6, Pennsylvania

CIRCLE 130 ON READER-SERVICE CARD

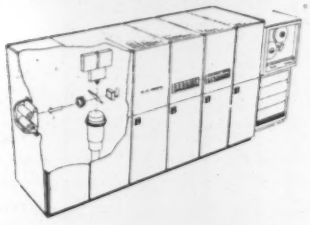
POWER RELAY



New Type 136 heavy current switching or multi-pole Relay (up to 24 contact points) for ac or dc exceeds 5,000,000 mechanical operations with 4PDT 15-amp contacts.—*Telex/Aemco, 10 State St., Mankato, Minn.*

CIRCLE 325 ON READER-SERVICE CARD

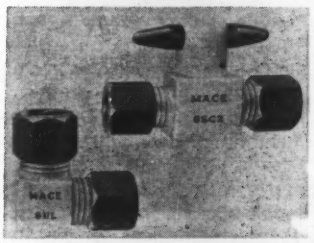
HIGH SPEED RECORDER



New S-C High Speed Recorder with hard copy option can produce paper copy and 35-mm film simultaneously or can be adjusted for individual operation of either output medium.—*General Dynamics/Electronics Information Technology Div., 1895 Hancock St., San Diego 12, Calif.*

CIRCLE 326 ON READER-SERVICE CARD

TEFLON VALVES AND FITTINGS

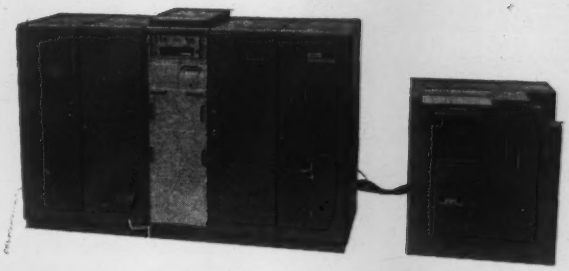


New Manual Instrumentation Valves precision machined of pressure molded Teflon are available in stock sizes of 6, 8 and 10 mm, also electrically operated poppet and rotary-type valves with orifice sizes $\frac{1}{16}$" to $\frac{3}{8}$". Tube fittings, in standard sizes of 4, 6, 8, 10 and 12 mm, include straight, tee and elbow unions, union reducers, male and female adapters, panel unions and hose ends. Designed for low pressure systems not exceeding 15 psi.—*Mace Corp., 500 W. Valley Blvd., San Gabriel, Calif.*

CIRCLE 327 ON READER-SERVICE CARD

FACT

Flexible Automatic Circuit Tester



AUTOMATED PROGRAMMING FOR CIRCUIT TESTS

Now you can virtually eliminate the engineering man hours required to program high-volume wiring circuit tests. With **FACT** (Flexible Automatic Circuit Tester) you can take information directly from standard wiring lists and process as many as 300 **FACT** cards per minute! And with **FACT** you get other major benefits. For free illustrated brochure write: L. W. Risner, Hughes El Segundo, Los Angeles 9, Calif.

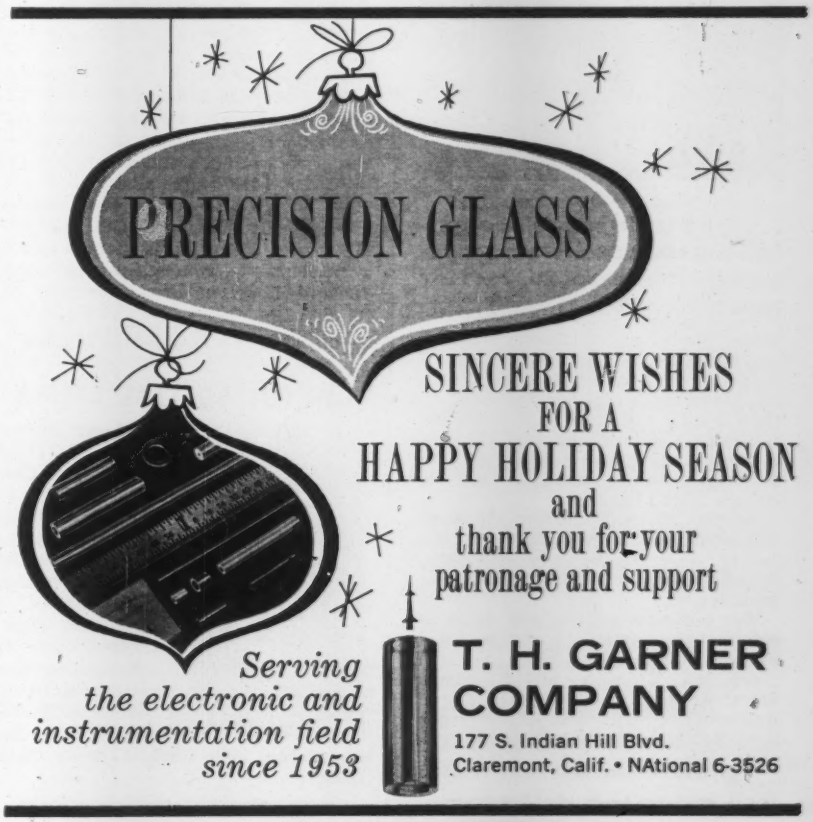
Shown above: 24,000 wire termination FACT-RC

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY

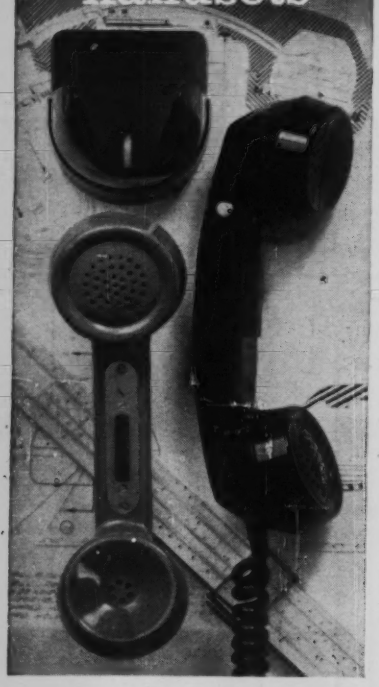
CIRCLE 131 ON READER-SERVICE CARD



CIRCLE 132 ON READER-SERVICE CARD

NEW

Stromberg-Carlson lightweight telephone handsets



. . . for a wide range of applications such as dictating systems, mobile radio, carrier and microwave.

These new lightweight Stromberg-Carlson handsets, No. 33 and No. 35, incorporate push-to-talk switches, broadening the range of their applications. Both feature high-gain, high-efficiency transmitter and receiver.

The No. 33 model is furnished with a bar-type switch, located on the underside of the handle.

The No. 35 handset is furnished with a button switch on the side of the handle near the receiver end. Also available with both button and bar switches.

For technical details and ordering information, contact any of these sales offices: Atlanta—750 Ponce de Leon Place, N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Ave.; San Francisco—1805 Rollins Rd.

GENERAL DYNAMICS

TELECOMMUNICATION

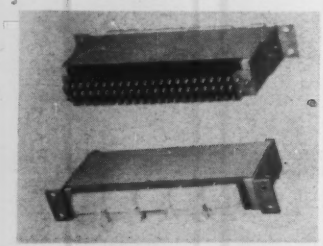
CIRCLE 133 ON READER-SERVICE CARD

MAGNETIC TAPES

New high-resolution Heavy Duty Instrumentation Tapes Nos. 998 and 999 for recording of very short wave lengths have 0.48 mil high-potency oxide coating on 1.5 mil polyester base (on No. 998) 1 mil base on No. 999. Available in standard widths of ¼", ½", ¾" and 1".—*Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.*

CIRCLE 328 ON READER-SERVICE CARD

TEN KEY SWITCH



New 1000-Series Ultra Switch, fully mechanical without electronics, is available as SPDT or DPDT model, rated 5 amp at 125 and 250 vac, UL approved, 20 vdc/3 amp at sea level and 2.5 amp at 50,000 ft, inductive. Resistive ratings: 5 amp from sea level to 50,000 ft altitude. Model 1000-V has single row of keys, mounted vertically; Model 1000-H has double row of 5 keys each, mounted horizontally.—*Ultronics Systems Corp. 7300 N. Crescent Blvd., Pennsauken, N. J.*

CIRCLE 329 ON READER-SERVICE CARD

LAB POT VOLTAGE SUPPLY

New Model BS (TC)-2A Batt-Sub Constant Voltage Supply replaces drifting dry and wet-cell batteries, has voltage regulation of ±0.001% for a ±10% input change, temperature coefficient of ±0.001%/°C. Bulletin. — *Dynage, Inc., 390 Capitol Ave., Hartford, Conn.*

CIRCLE 330 ON READER-SERVICE CARD

Labac,

a solid-state, variable, a-c power regulator . .

. . . can be used to smoothly proportion the a-c voltage from a 115/230 v. power line into a resistive load either by manually turning a knob . . .

. . . or in response to a low level control current from an external source.

0-1 ma. CONTROL

A 1-ma. CONTROL CURRENT into Labac's 200-ohm input impedance effectively controls its full rated power — up to 40a. in some models. Thus, power gain up to 40 million is achieved. (Input can be matched to commonly used control currents, e.g. 1-5 ma.)

NO VACUUM TUBES — NO MOVING PARTS

LABAC uses two silicon controlled rectifiers pulsed by a magnetic amplifier for instantaneous (one cycle) power regulation by either manual or remote control.

REPLACES bulky saturable core reactors or thyratrons.

REPLACES mechanical contractors in ON-OFF applications.

REPLACES motor-driven variable transformers in applications involving resistive loads.

APPLICATIONS: May be connected to set-point meters, recorder-controllers, or thermistor devices for closed loop temperature control to heaters, laboratory ovens, kilns, etc. . . . for theatre light dimming, operation of sales demonstrators and experimental apparatus.

LIGHT DIMMING • LABORATORY OVENS • DEMONSTRATORS

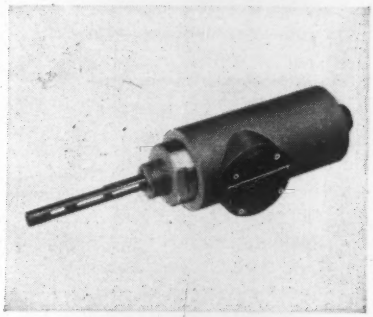
R I RESEARCH INCORPORATED

P.O. BOX 6164 Y, MINNEAPOLIS 24, MINN.

CIRCLE 134 ON READER-SERVICE CARD

PROCESS CONTROL REFRACTOMETER

Sugar refining, food, chemical and other process industries



- **Vat or pipeline installation**
- **Continuous electrical output for chart recording or process control**
- **Accuracy unaffected by bubbles, suspended solids or turbulent flow**
- **Drift free, temperature compensated and self-calibrating transistorized electronics**
- **Rugged, maintenance-free construction**
- **Stainless steel and glass insertion probe**

Output: 0 to 1 volt dc (into 500Ω) from 20° to 35° Brix ±0.1° (1.364 to 1.390 ±.0002 refractive index).

Temperature Compensation: ± 0.1° Brix (± .0002 refractive index) from 60° to 85° F.

Power Required: 115 volts, 60 cps.

Size: 3″ x 4½″ x 14″; Standard 1-inch pipe fitting.

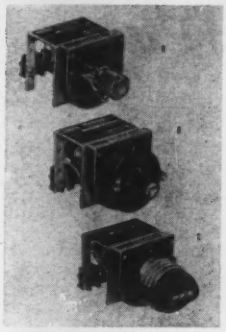
OPTICS TECHNOLOGY, INC

248 Harbor Boulevard
Belmont, California
LYtell 1-0358 (Area Code 415)

7479

CIRCLE 135 ON READER-SERVICE CARD

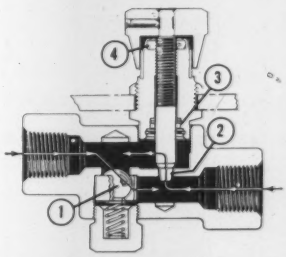
PRESET CONTROL UNITS



New Models of Preset Units for heavy-duty control functions are oil tight; accomodate single or multi-gang potentiometers and molded terminal strips; fit into NEMA, JIC or UL enclosures. Potentiometers resistance is 2.5 K, wattage 1 watt at 65°C. Model SC-CP is single-turn unit, Models SC-CM and SC-CM are ten-turn units.—*Oilgear Co.*, 1570 *W. Pierce St., Milwaukee* 4, *Wis.*

CIRCLE 331 ON READER-SERVICE CARD

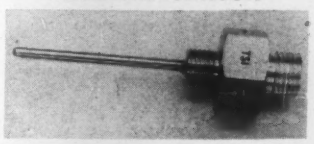
FLOW CONTROL VALVE



New 1" Auto-Ponent Flow Control Valve operates at 5000 psi oil or air with a 5:1 safety factor, has body of steel or stainless-steel forgings. Effortless needle adjustments possible under maximum rated pressure. "Quad" Ring pressure gland seal seals off needle threads and upper housing. 3 models: Standard, mounted and supported in line; Knob and Dial (illustrated), and Knob and Dial for panel mounting.—*Auto-Ponents, Inc.*, 3001 *Grant St., Bellwood, Ill.*

CIRCLE 332 ON READER-SERVICE CARD

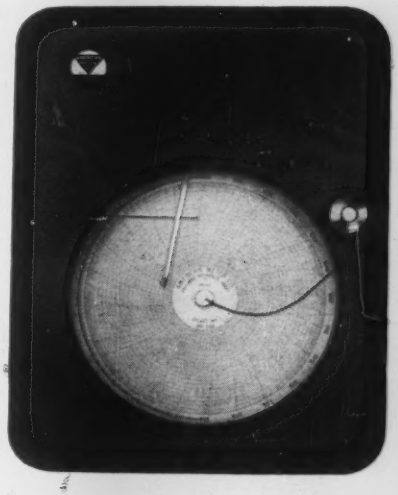
NUCLEAR SENSOR



New platinum-immersion Temperature Sensor meets nuclear environments of 1 (11) ergs/gram (c) gamma and 1 (15) n/cm², En> 2.9 Mev nuft nutron flux, is rated 100 ohms at 32°F and covers range of −364 to 1000°F.—*Temperature Systems, Inc.*, 1871 *S. Orange Dr., Los Angeles* 19, *Calif.*

CIRCLE 333 ON READER-SERVICE CARD

PRESSURE and TEMPERATURE RECORDERS



American® single and two-pen Pressure Recorders for pressures from 30 inches vacuum to 10,000 psi.

- Pressure elements individually calibrated over full range.
- Variety of chart drives available.*
- Helical elements of different ranges are interchangeable.
- Aluminum alloy, dust and moisture-proof case.

See Bulletin 400.

American Temperature Recorders for an accurate record of flowing temperatures.

- No ambient temperature errors.
- High sensitivity and torque. Fast speed of response.
- Standard 0-150°F. range. Other ranges available.
- Variety of chart drives available.*

See Bulletin 408.

**24-hour mechanical, 110-v. 60-cy. electric, or Gasclok® chart drives.*

AMERICAN METER COMPANY

Sales Offices in Principal Cities

CIRCLE 136 ON READER-SERVICE CARD

Resolution is stepless, TC is better than 50ppm/°C and they are great for high ambient temperatures. Yet, Infinitrims are interchangeable with ordinary trimming potentiometers.

Available in the popular ½" square shape as well as round, in values from 100 ohms to 10K.

Up date your circuits now . . . improve performance and reliability.

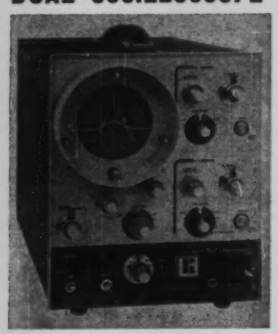
intellux
INCORPORATED

Write for complete "Infinitrim Data"

P.O. Box 929, Santa Barbara, Calif.

CIRCLE 138 ON READER-SERVICE CARD

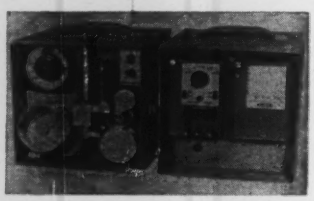
DUAL OSCILLOSCOPE



New Model 5Mc-2P/R Dual Gun Oscilloscope has two identical vertical amplifiers, each with a band pass of dc to 5 Mc and a sensitivity of 100 mv to 100 v, continually adjustable. A built-in pre-amplifier increases the sensitivity of the lower amplifier to 1 mv/cm. The sweep is from a Schmitt Trigger with both internal and external triggering capabilities. Linearty of sweep is 1% from a constant current, RC network.—*Packard Bell Electronics, Box 337, Newbury Park, Calif.*

CIRCLE 334 ON READER-SERVICE CARD

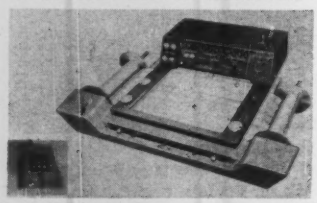
DUST AND GAS SAMPLER



New Phototape Sampler automatically collects samples of dust from air on paper tape and records concentration of dust or gas on strip chart. Consists of two units: Tape sampler itself contains vacuum pump, time controls, air sampling mechanism, and photohead attachment of densitometer.—*Gelman Instrument Co., 106 N. Main St., Chelsea, Mich.*

CIRCLE 335 ON READER-SERVICE CARD

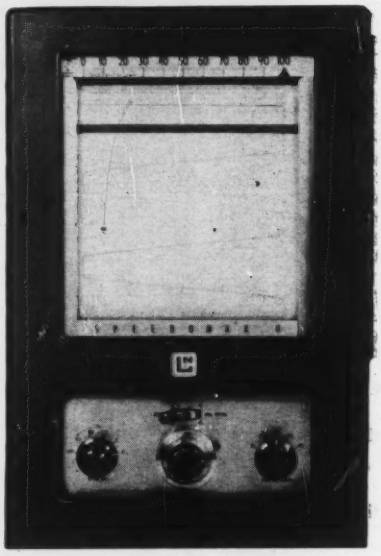
DIGITAL DATA READER



New Digital Data Reader consists of an X-Y reading head, 16" paper or film transport, and keyboard. Output is to typewriter.—*Gerber Scientific Instrument Co., Box 305, Hartford 1, Conn.*

CIRCLE 336 ON READER-SERVICE CARD

NEW!
Speedomax® H
AZAR
Recorder



This L&N Speedomax H AZAR (Adjustable Zero, Adjustable Range) Recorder provides a new level of recording versatility for research and development work. With any calibrated span between 0.67 and 100 mv, and any zero suppression between −50 and +50 mv, it can plot virtually any physical or electrical quantity that can be converted into d-c millivolts. This flexibility is achieved with six switch-selected spans and five steps of zero suppression, plus continuous adjustment of each span and zero step.

List No. — 3-961-000-186-6-360 Speedomax H AZAR Recorder.

Measuring Circuit—D-C potentiometer with automatic gain control.

Electrical Span—Switch-selected: 2, 5, 10, 25, 50 or 100 mv. Continuously adj. span attenuator on each position reduces span to ⅓ of position.

Electrical Zero—Continuously adj. 10 mv, 10-turn potentiometer slidewire, fixed step switch to add 0, 10, 20, 30 and 40 mv to slidewire. Key provides "zero −", "zero +" and a "calibrate" position which calibrates the span.

Span Step-Response-Time Rating—One second.

Chart—Calibrated 0 to 100 in 6".

Chart Speed—360" per hour.

Power Requirements—Operates on 120 v, 60 c.

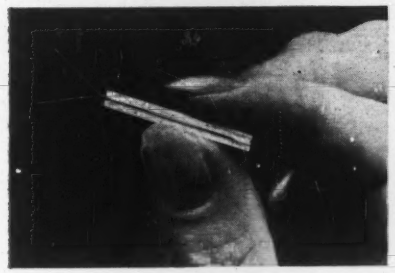
Price — $995.00 f.o.b. Philadelphia or North Wales, Pa. (subject to change without notice). Use List No. 3-961-000-186-6-360 when ordering from L&N, 4955 Stenton Ave., Phila. 44, Pa.

Pioneers in Precision

LEEDS & NORTHRUP

CIRCLE 337 ON READER-SERVICE CARD

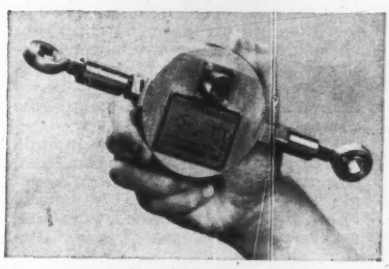
Weldable Strain Gage



Precise, rugged gage is capable of continuous operation at 750°F and dynamic test to 1500°F. These gages employ one-piece etched wire filaments in swaged stainless steel tubes, and are suitable for use from cryogenic to elevated temperatures. They are also available with inherent temperature compensation (no dummy gages required). Easy installation through the use of stored-energy welding equipment eliminates complicated bonding and curing processes. Also available in integral lead strain gage versions.

CIRCLE 370 ON READER-SERVICE CARD

Force Measuring Transducers



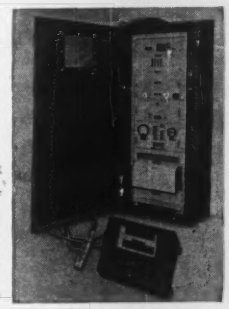
These rugged, ring-configuration load cells measure both tension and compression loads at high temperatures over a full scale range of 100 to 500,000 lbs. They can withstand considerable overload without destroying calibration and have been successfully used in radiation environments. Sensing is performed by resistance-type, high temperature welded strain gages in bridge configuration within a ring. Total all-cause error is within ±1% over a temperature range of −300°F to +750°F. Units can be provided sealed.

MICRODOT INC.

220 Pasadena Ave.
South Pasadena, Calif.

CIRCLE 139 ON READER-SERVICE CARD

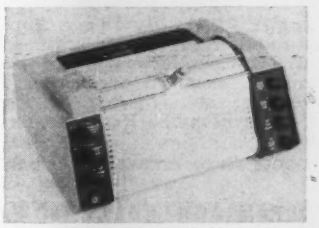
HOT METAL LADLE SCALE



New electronic Hot Metal Ladle Scale that controls ingot weight ±100 lb to 30,000 lb is incorporated in an ingot pouring system. Measures loss of weight from hot metal teeming ladle. Printed record gives ingot set point weight and actual weight.—*Gilmore Industries, Inc., 3355 Richmond Rd., Cleveland, Ohio.*

CIRCLE 337 ON READER-SERVICE CARD

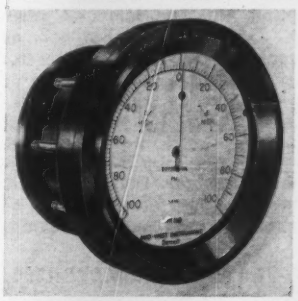
X-Y PLOTTERS



New RECOMP digital high-speed X-Y Plotters accept analytical or discontinuous function and present these data in graph form for visual interpretation. Plots in 0.01" increments with speeds of 200 increments/sec at 0.01" resolution. Other features include self-contained power supply allowing immediate plug-in installation to either the RECOMP II or the RECOMP III computer; solenoid operated pens, with interchangeable varicolored ballpoints, and full-view writing panel with roll paper feed.—*Autonetics Industrial Products Div. North American Aviation Inc., 3400 E. 70 St., Long Beach 5, Calif.*

CIRCLE 338 ON READER-SERVICE CARD

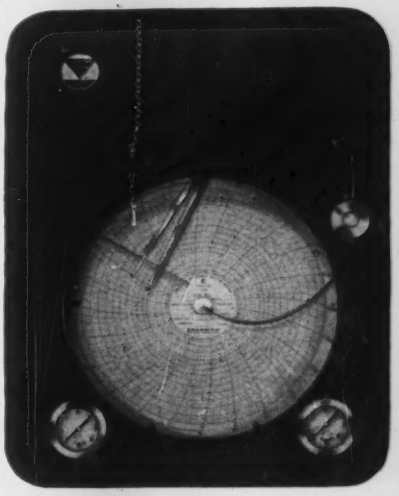
DIFF PRESS INDICATOR



New Model 110 Economy Differential Pressure Indicators is for 20 to 400 psid at working pressures to 1000 psig. Standard models are for use with non-corrosive fluids, stainless-steel models for corrosive fluids. Compact, light-weight, with full over-range protection. Bulletin.—*Mid West Instrument, 1021 E. State Fair, Detroit 3, Mich.*

CIRCLE 339 ON READER-SERVICE CARD

SERIES A-88 CONTROLLERS



Designed to give rugged, dependable performance, American® Series A-88 Controllers provide versatile, positive control of... Flow, Pressure, Liquid Level and other continuous process variables...accurately and automatically.

- Rugged, null-type, non-bleed Relay.
- Simple, in-the-field linkage adjustment.
- Maximum Proportional Band changes with minimum output pressure changes.
- Proportional Band easily widened without disconnecting instrument tubing.
- Spring-closing Reset Valve sealed with bellows and calibrated according to time.

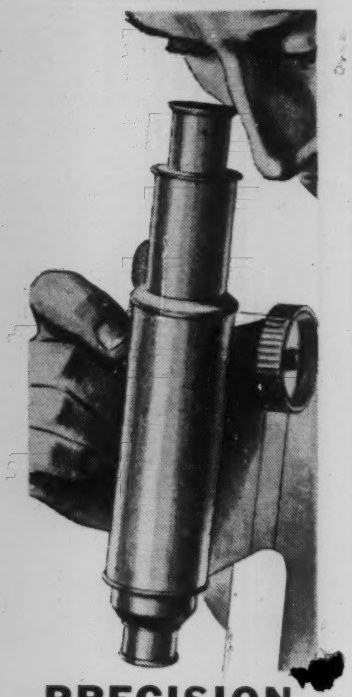
Ask for Bulletin 406.

AMERICAN METER COMPANY

Sales Offices in Principal Cities

CIRCLE 140 ON READER-SERVICE CARD

QUALITY TESTED 97 TIMES



PRECISION TUBING

When you specify Precision Tubing, you can depend upon quality material and quality workmanship . . . both checked and rechecked more than 97 times from receipt of base stock to the boxing of your order. Skilled technicians and qualified engineers check every operation using the finest laboratory equipment available. The chemistry of the metal itself is scrutinized; even the grain size is photomicrographed. Finally, Precision's exclusive "Electro-Scan" process is put to work, electronically testing for any hidden defects in the finished tubihg.

Ninety-seven reasons why you can eliminate anxious moments—specify Precision Tubing. For complete details on Precision Tubing write to. . . .

PRECISION TUBE CO., INC.
North Wales, Pa.

PRECISION
TESTED BY ELECTRO-SCAN

CIRCLE 145 ON READER-SERVICE CARD

I&CS NEW LITERATURE

CONTROL SYSTEMS CONTROLLERS

PROCESS INSTRUMENTS. 52-page condensed Catalog G-1a describes ElectroniK instruments, ElectriK and pneumatic Tel-O-Set lines, millivoltmeters, primary sensors, filled-system thermometers, pressure gages and transmitters, flow and liquid level meters, Dur-O-Pulse telemetering systems, special purpose instruments, computers and data handling systems, basic industrial controls, and control valves.—Minneapolis-Honeywell Regulator Co., Industrial Div.. Wayne and Windrim Aves., Phila. 44, Pa.

CIRCLE 340 ON READER-SERVICE CARD

CASCADE CONTROL. 4-page Application Bulletin 91-53P-04 outlines elements of cascade control in paper, petroleum, chemical production, food processing, etc.—Fischer & Porter Co., 26 Jacksonville Rd., Warminster, Pa.

CIRCLE 341 ON READER-SERVICE CARD

PROGRAM CONTROLLERS. 2-page Bulletin 661 describes drum-type program controllers for pressure, temperature, viscosity, sound, color, etc. —Tenor Company Div. Milwaukee Chaplet & Mfg. Co., Inc., 13460 W. Silver Spring Dr., Butler, Wis.

CIRCLE 342 ON READER-SERVICE CARD

PROPORTIONAL CONTROLLER. 4-page Instrument Section 53 describes electronic proportional controller.—Thermo Electric Co., Inc., Saddle Brook, N. J.

CIRCLE 343 ON READER-SERVICE CARD

CONTROL VALVES, ACTUATORS

CONTROL VALVE COMPARISON. 8-page "Comparison" booklet discusses various features of control valve construction and operation.—Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

CIRCLE 344 ON READER-SERVICE CARD

CONTROL VALVE NOISE. 8-page Technical Manual TM-9 presents problem of noise emitted by control valves and explains sonic vibation.—Fisher Governor Co., Marshalltown, Iowa.

CIRCLE 345 ON READER-SERVICE CARD

TEMPERATURE REGULATORS. 8-page Bulletin 1014 is a selection guide for direct-operated, piloted and air-control temperature regulators.—Spence Engineering Co., Inc., Walden 2, N. Y.

CIRCLE 346 ON READER-SERVICE CARD

CAM-OPERATED INDEXING UNIT. 16-page Specification Bulletin 26 describes Model ST-A9AB Indexing Units.—Standard Tool & Mfg. Co., 738 Schuyler Ave., Lyndhurst, N. J.

CIRCLE 347 ON READER-SERVICE CARD

NEW DE-LINE annunciator has 70% MORE ENGRAVING AREA for more precise trouble legends

Scam De-Line annunciators, your systems' sentry, now offers the new MAGNA-PLAC nameplate which provides 70% more engraving area.

The MAGNA-PLAC nameplate gives the engineer increased space to more accurately describe condition variations or to employ larger characters for greater visibility. It is interchangeable with standard Scam nameplates and optionally available *without extra charge.*

Other De-Line features include side or stack mounting for practical, *economical* system expansion; a single plug-in relay for both normally open *or* normally closed contacts; and sequence options *after* installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

Complete Monitoring Systems for Industry

SCAM®

INSTRUMENT CORP.

Dept. G, 3101 N. Lowell Ave.
Chicago 41, Ill.

Representatives in Principal Cities

WRITE FOR MORE INFORMATION on De-Line MAGNA-PLAC. Just sign and attach coupon to company letterhead.

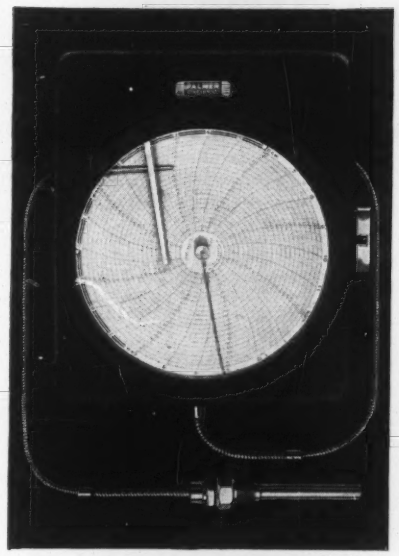
NAME .....

CIRCLE 142 ON READER-SERVICE CARD

PALMER

MERCURY ACTUATED RECORDERS

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer Master Craftsmen



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: —40 to 1000°F. or Equivalent in °C.

Send for Bulletin No. 45
Consult your Classified Directory

PALMER

PALMER THERMOMETERS, INC.
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers
Cincinnati 12, Ohio

CIRCLE 143 ON READER-SERVICE CARD

WEDGE GATE VALVES. 24-page Catalog 425-A describes corrosion-resistant valves for the paper, chemical and petroleum industries.—W. G. Rovang and Associates, Inc., 1945 N. Columbia Blvd., Portland, Ore.

CIRCLE 348 ON READER-SERVICE CARD

VALVE SIZING. 4-page technical paper "A Practical Look at Valve Sizing" explains the proper approach to this problem.—Jordan Valve, Div. of Richards Industries, Inc., 6013 Wiehe Rd., Cincinnati 37, Ohio.

CIRCLE 349 ON READER-SERVICE CARD

BALL VALVES. 4-page Bulletin PB911 illustrates and describes the Ludeman Rotoflo valve.—General Kinetics Corp., 197 S. Van Brunt St., Englewood, N. J.

CIRCLE 350 ON READER-SERVICE CARD

PLUG VALVE ACTUATOR. 4-page Bultin describes Bettis Robotarm actuator.—Bettis Corp., P. O. Drawer 9365, Houston 11, Tex.

CIRCLE 351 ON READER-SERVICE CARD

VALVE POSITIONER. 2-page Data Sheet 105 gives details of operation and complete specs and dimensions of Model J positioner.—Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

CIRCLE 352 ON READER-SERVICE CARD

TEMPERATURE

BIMETAL THERMOMETERS. 16-page General Catalog 09-100 covers industrial, laboratory, Navy, and pocket-types bimetal thermometers.—Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

CIRCLE 353 ON READER-SERVICE CARD

THERMOWELLS. 4-page Catalog TT-305 covers thermowells for filled systems.—Trinity Equipment Corp., Cortland, N. Y.

CIRCLE 354 ON READER-SERVICE CARD

MINI THERMOCOUPLES. 6-page Product Data 4336 describes and tabulates HT Micro-Miniature Thermocouples.—Baldwin-Lima-Hamilton, Electronics and Instrumentation Div., Waltham 54, Mass.

CIRCLE 355 ON READER-SERVICE CARD

INDICATING PYROMETERS. 4-page Instrument Section 25-4 describes multi-point pyromillivoltmeter-type pyrometers.—Thermo Electric Co., Inc., Saddle Brook, N. J.

CIRCLE 356 ON READER-SERVICE CARD

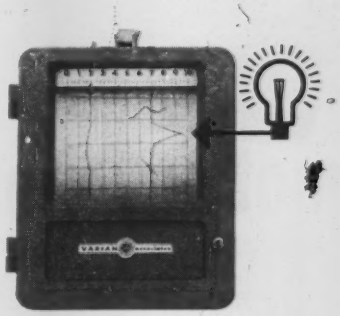
REMOTE-SENSING TEMP INDICATOR. 4-page Catalog 10 and Price List provide details on Pyrotel temperature indicators.—Mason Instrument Co., Inc., 222 Valley Pl., Mamaroneck, N. Y.

CIRCLE 357 ON READER-SERVICE CARD

PLATINUM TRANSDUCERS. 4-page Special Product Note 5600 covers platinum resistance temperature sensors.—Trans-Sonics, Inc., Box 328, Burlington, Mass.

CIRCLE 358 ON READER-SERVICE CARD

VARIAN
Potentiometer
RECORDERS
Offer exceptional
versatility because...



THERE ARE ACCESSORIES FOR

ALARM/CONTROL

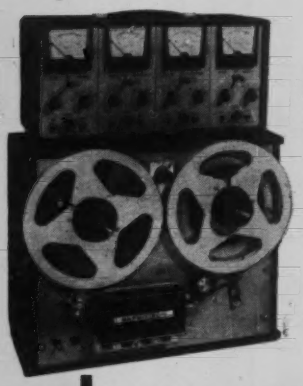
Alarm and control switches, and retransmitting slide wires, add a valuable dimension of simple control to the already-versatile two-channel G-22. With these optional accessories they can work unattended to control two variables within the 1% accuracy of the recorder, while making a permanent record of what has happened.

1% accuracy, spans from 10 mv to 500 v, 1 second full-scale balance time, two chart speeds standard, four optional (½"/hr. to 16"/min.), full scale zero adjust, event markers and other options. Portable and rack-mounted models available from $1,075. Write Instrument Division:

VARIAN associates
PALO ALTO 27, CALIFORNIA

CIRCLE 144 ON READER-SERVICE CARD

data recorders expensive?



not any more

now, Mnemotron gives you a complete, easy-to-use 4-channel analog tape record/reproduce system with **0.2% precision** for only **$3,495**

Complete with 10½" reel tape transport, rack mounted

Mnemotron offers a unique pulsed FM principle and fully transistorized, self-contained unit that records all analog • data • data acquisition • storage, analysis and reduction • time scale contraction and expansion • programming • computer read IN and read OUT • dynamic simulation. With Mnemotron, you can do more with paper recorders . . . expanding frequency response and channel capacity, saving you from being deluged with data, permitting you to look at the same data at different time scales.

Model M204 features:
Any 2 adjacent speeds: 3¾, 7½, 15 ips. Added low speed available on special order.

Frequency Response:
- DC—800 cps @ 15 ips
- DC—400 cps @ 7½ ips
- DC—200 cps @ 3¾ ips

Linearity: 0.2% full scale.
Noise: Less than —50 db full scale.
Crosstalk: Below 70 db.
Extended range systems also available.

Write, wire, phone today for complete details.

MNEMOTRON CORPORATION

precision analog data tape recorders and biological computers
41 South Main Street, Pearl River, N. Y.
• 'phone PEarl River 5-4015 (914)
• Cables: Mnemotron

CIRCLE 141 ON READER-SERVICE CARD

HEAT SENSORS. 12-page Catalog V 680 describes and tabulates thermistors and varistors, with typical electrical curves.—Victory Engineering Corp., 128-30 Springfield Ave., Union, N. J.

CIRCLE 359 ON READER-SERVICE CARD

INSULATED T/C MATERIALS. 12-page Catalog 2550 describes manufacture and lists specs and data of mineral-oxide-insulated thermocouple materials.—Temptron, Inc., 7030 Darby Ave., Reseda, Calif.

CIRCLE 360 ON READER-SERVICE CARD

PRESSURE, FORCE, WEIGHT

PRESSURE GAGES. 4-page Bulletin SF-761 describes Acragage line of pressure, vacuum, compound, and test gages.—Fulton Sylphon Div. Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.

CIRCLE 361 ON READER-SERVICE CARD

WELDABLE STRAIN GAGES. 2-page Data Sheet 4324 describes line of weldable strain gages.—Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Waltham, Mass.

CIRCLE 362 ON READER-SERVICE CARD

LOAD CELL SYSTEM. 2-page Bulletin IF-10 describes application of load-cell system to weigh ductile iron in foundry.—Martin-Decker Corp., 3431 Cherry Ave., Long Beach 7, Calif.

CIRCLE 363 ON READER-SERVICE CARD

PRESSURE MEASUREMENT. 6-page bulletin illustrates and describes ToPazometer measuring pressure drop, controlling pressure, and testing of flowmeters.—ToPaz Inc., 2525 South Blvd., Houston 6, Tex.

CIRCLE 364 ON READER-SERVICE CARD

PRESSURE, TEMPERATURE, SPEED. 20-page Bulletin 258 is a composite catalog describing ElectroSyn instrumentation for pressure, temperature, and speed, complements to ElectroSyn systems, and strain gage-type of pressure instrumentation.—Detroit Controls Div., American-Standard, 5900 Trumbull Ave., Detroit 8, Mich.

CIRCLE 365 ON READER-SERVICE CARD

FORCE TRANSDUCER. 2-page Bulletin TB-1 describes with specs force measuring transducers (load cells).—Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

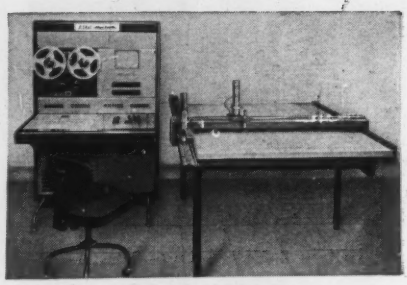
CIRCLE 366 ON READER-SERVICE CARD

DIFF PRESS INDICATORS. 2-page Bulletin E5 and six data sheets cover design, operation, applications, and specs of Deltadyne® pressure and differential pressure indicators.—Porous Media, Inc., Subs. of Pall Corp., Glen Cove, N. Y.

CIRCLE 367 ON READER-SERVICE CARD

AUTOMATIC FILLING BALANCE. 4-page Bulletin 102A describes line of low-weight-range automatic filling balances for granular or powdered substances.—Mettler Instrument Corp., Box 100, Princeton, N. J.

CIRCLE 368 ON READER-SERVICE CARD



New, fully automated Aero/Digitork X-Y PLOTTER with digital input/output

Check These Key Features:
- 100% digital actuation
- .0015" operating accuracy
- All solid-state electronics
- Input-output format includes punched tape or cards, or magnetic tape
- Option: point-to-point or continuous line modes and automatic incremental scale factors
- Models: from 9" x 17" to 5' x 10' plotting area

New Brochure: Write for brochure describing applications, specs. Or phone Frank McWilliams, Mgr., Coordinatograph Sales, GL 7-3000.

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CIRCLE 373 ON READER-SERVICE CARD

TELEMETERING TRANSMITTER. 3-page Specification Data Bulletin 231-11.201-1 describes in-stream, float-operated Chronoflo Telemetering Transmitter, Model 231-11.—B-I-F Industries, Box 276, Providence 1, R. I.

CIRCLE 374 ON READER-SERVICE CARD

ULTRASONIC FLOWMETER. 4-page Bulletin S9A describes and illustrates Glennite ultrasonic flowmeter.—Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

CIRCLE 375 ON READER-SERVICE CARD

HIGH-VISCOSITY FLOW TUBE. 2-page Specification Data 160.201-1 describes Schlag-Jorissen Model 160 Flow Tube for high-viscosity fluids.—B-I-F Industries, Box 276, Providence, R. I.

CIRCLE 376 ON READER-SERVICE CARD

TIME, COUNT

DIGITAL COUNTERS. 8-page Form 222864 describes line of 108 high-speed low-torque direct-drive mechanical counters for digital readout applications.—Veeder-Root Inc., 70 Sargeant St., Hartford 2, Conn.

CIRCLE 377 ON READER-SERVICE CARD

TIME-FREQUENCY STANDARDS. 2-page Bulletin 4.4 describes and specifies precision chronometers.—Westrex Communication Systems Div. Litton Systems, Inc., 540 W. 58 St., New York 19, N. Y.

CIRCLE 378 ON READER-SERVICE CARD

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CIRCLE 146 ON READER-SERVICE CARD

SEQUENCE TIMER. 2-page Bulletin No. 1 illustrates and describes battery-powered chronometric timer.—Geodyne Corp., 180 Bear Hill Rd., Waltham 54, Mass.

CIRCLE 379 ON READER-SERVICE CARD

TIMERS. 4-page Bulletin B-9 describes synchronous motors, timers, and panel timers.—Bristol Motors Div. Vocaline Co., of Amer., Old Saybrook, Conn.

CIRCLE 380 ON READER-SERVICE CARD

TESTING, GAGING

TRANSMISSION LINE TESTING. 6-page Application Note 53 describes pulse-reflection techniques for giving a direct reading of transmission line characteristic impedance with a sampling oscilloscope.—Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

CIRCLE 381 ON READER-SERVICE CARD

TEST INSTRUMENTS. 24-page Short Catalog ES-10 lists complete line of integrated sound, vibration and data analysis instrumentation.—B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.

CIRCLE 382 ON READER-SERVICE CARD

HIGH VOLTAGE TEST EQUIPMENT. 4-page Product Data Sheet K, KS, KM describes high-voltage test sets.—Peschel Electronics, Inc., Towners, Patterson, N. Y.

CIRCLE 383 ON READER-SERVICE CARD

T/C SIGNAL CONDITIONER. 2-page Bulletin 201 describes Model TSC-1 thermocouple signal-conditioner.—Astra Technical Instrument Corp., 9905 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 384 ON READER-SERVICE CARD

WEIGHT, CENTER-OF-GRAVITY LOCATOR. 4-page brochure details features, operating theory, and applications of 3 weight and center-of-gravity locators for missile and space industry.—Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.

CIRCLE 385 ON READER-SERVICE CARD

MAGNETIC-TAPE CERTIFIER. 2-page Bulletin 61-CA describes automatic inspection system which locates defects in tapes used for computers, etc.—Cybetronies, Inc., 132 Calvary St., Waltham, Mass.

CIRCLE 386 ON READER-SERVICE CARD

DIAL INDICATOR CHECKING. 6-page pocket-size brochure describes step-by-step procedures for checking dial indicators.—Dwight Instrument Co., 593 New York Ave., Lyndhurst, N. J.

CIRCLE 387 ON READER-SERVICE CARD

GROOVE GAGES. 8-page Catalog 1-A describes and illustrates five complete Reliant groove gage sets.—Boice Gages, Inc., Hyde Park, N. Y.

CIRCLE 388 ON READER-SERVICE CARD

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CIRCLE 148 ON READER-SERVICE CARD

PROFILOMETERS. 12-page general catalog covers line of Profilometer instrumentation for the measurement and control of surface roughness.—Micrometrical Mfg. Co., 5621 So. State Rd., Ann Arbor, Mich.

CIRCLE 389 ON READER-SERVICE CARD

STOCK PLUG GAGES. 4-page monthly bulletin offers listing of over 3,000 sizes of individual Class "X" cylindrical plug gages in stock. Mailed monthly free-of-charge for the asking.—Deltronic Corp., 929 Baker St., Costa Mesa, Calif.

CIRCLE 390 ON READER-SERVICE CARD

RECORDERS

INKLESS EVENT RECORDER. 4-page brochure Form 6107 describes Model 620 inkless event recorder with Tempen which can operate 50 days without a change in charts.—Esterline Angus Instrument Co., Inc., Box 596, Indianapolis, Inc.

CIRCLE 391 ON READER-SERVICE CARD

X-Y RECORDERS. 6-page bulletin describes and specifies Model 300 and Model 400 X-Y recorders.—Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.

CIRCLE 392 ON READER-SERVICE CARD

PORTABLE RECORDER. 4-page Catalog REC-6 illustrates and describes miniature recorder for volts, amps, temperature, etc.—Amprobe Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.

CIRCLE 393 ON READER-SERVICE CARD

RECORDING MATERIALS. 8-page Catalog R-61 explains qualities and uses of various photo recording materials.—Ansco Div. of General Aniline & Film Corp., Binghamton, N. Y.

CIRCLE 394 ON READER-SERVICE CARD

DATA HANDLING

PRINTING SYSTEM. 4-page Bulletin 61-41 describes RBP-Series buffer and control units for connecting data processors to high-speed rotary-bar printers.—DI-AN Controls, Inc., 944 Dorchester Ave., Boston 25, Mass.

CIRCLE 395 ON READER-SERVICE CARD

DATA ACQUISITION. 12-page Bulletin SCE-2 describes instruments for data acquisition systems featuring double-level isolation in which both chassis and circuitry are isolated from each other and from ground.—Computer Engineering Associates, Affil. of Susquehanna Sciences, Inc., 350 N. Halstead, Pasadena, Calif.

CIRCLE 396 ON READER-SERVICE CARD

MAGNETIC DRUM HEADS. 2-page Bulletin 3.1C describes miniature magnetic heads for recording digital data on drums.—Westrex Recording Equipment Div. Litton Systems, 335 N. Maple Dr., Beverly Hills, Calif.

CIRCLE 397 ON READER-SERVICE CARD

OPTICAL SCANNERS. 12-page pamphlet illustrates and describes optical scanners (electronic reading machines).—Farrington Electronics, Inc., 7019 Edsall Rd., Alexandria, Va.

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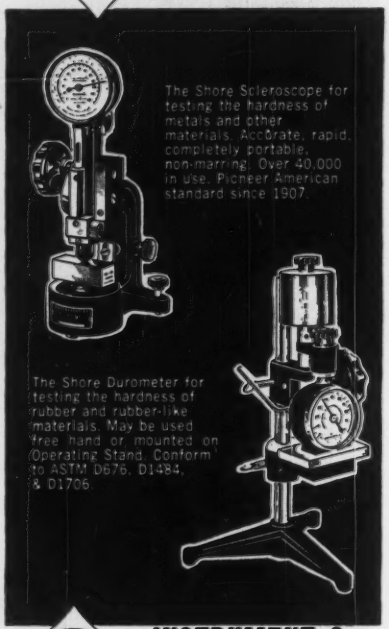
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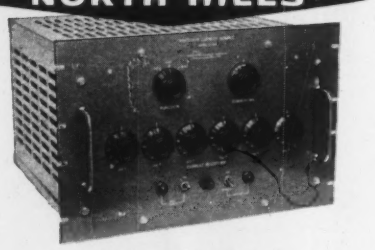

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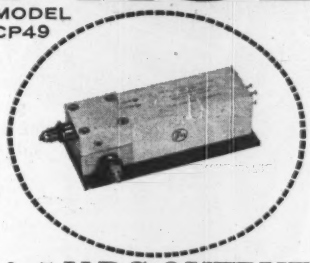

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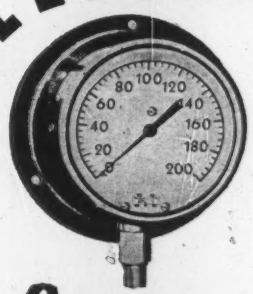

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PAPER-TAPE REELER. 2-page Bulletin RS-300 gives up to date information on OMNI-DATA bidirectional Paper-Tape Reeler Model RS-300.—Omnitronics, Inc., Subs. of Borg-Warner Corp., 511 N. Broad St., Phila 23, Pa.

CIRCLE 399 ON READER-SERVICE CARD

SEQUENTIAL ACCESS BUFFERS. 6-page Bulletin, 61-40 describes line of sequential-access buffers designed to accomodate a wide variety of data-manipulating programs.—Di-AN Controls, Inc., 944 Dorchester Ave., Boston 25, Mass.

CIRCLE 400 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC INSTRUMENTS

DIGI TIME/FREQUENCY METER. 6-page bulletin Form 2053-A illustrates and describes counter with continuous display.—General Radio Co., West Concord, Mass.

CIRCLE 401 ON READER-SERVICE CARD

SENSOR ANALOG MODULE. 2-page flyer PR2-2 describes Model SAM-1 for conditioning and amplifying output of low-level sensors.—Allegany Instrument Co. Div. Textron Electronics, Inc., 1091 Wills Mountain, Cumberland, Md.

CIRCLE 402 ON READER-SERVICE CARD

PHASE METERS. 6-page brochure illustrates and describes precision phase meters and their applications.—Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J.

CIRCLE 403 ON READER-SERVICE CARD

AMPLIFIERS. Package of 7 data sheets describes accelerometer-amplifier systems for shock and vibration measurements.—Columbia Research Labs., Inc., McDade Blvd. and Bullens Lane, Woodlyn, Pa.

CIRCLE 404 ON READER-SERVICE CARD

COMPACT OSCILLOSCOPE. 4-page Bulletin S117 illustrates and describes application of Model 260 2" oscilloscope.—Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.

CIRCLE 405 ON READER-SERVICE CARD

DIGITAL INSTRUMENTS. 5-page bulletin gives specs and information on 3000-Series modular digital voltmeters and ratiometers.—Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.

CIRCLE 406 ON READER-SERVICE CARD

SIGNAL GENERATOR. 2-page technical bulletin describes Model 412 FM signal generator intended primarily for check out of command receivers operating in the 400-550 mc band.—Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

CIRCLE 407 ON READER-SERVICE CARD

VOLTMETERS. Bulletin 61-132 describes a 0.25% True-RMS Electronic voltmeter, a floating-signal circuit VTVM, and a phase-discriminating dual-function VTVM.—Trio Laboratories, Inc., Plainview, L. I., N. Y.

CIRCLE 408 ON READER-SERVICE CARD

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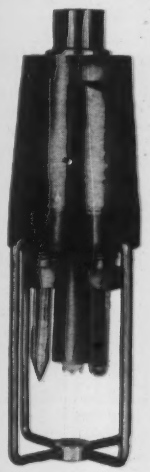

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NOISE GENERATOR. 2-page Bulletin EI-301A describes low-frequency noise generator with solid state chopper and regulated RMS level.—Elgenco, Inc. 1231 Colorado Ave., Santa Monica, Calif.

CIRCLE 409 ON READER-SERVICE CARD

CHROMATOGRAPHIC ANALYZERS. 14-page brochure illustrates and describes chromatographic analyzers for readout and control of process stream composition.—Foxboro Co., Foxboro, Mass.

CIRCLE 410 ON READER-SERVICE CARD

WATER SEPAROMETER. 4-page bulletin describes test instrument for checking water separation property of jet fuels.—Emcee Electronics, Inc., Box 3, Claymont, Del.

CIRCLE 411 ON READER-SERVICE CARD

GAS CHROMATOGRAPH. 16-page Bulletin FS-239 describes the Prep/Partioner, a preparative gas chromatograph for samples up to 10 ml.—Fisher Scientific Co., 711 Forbes Ave., Pittsburgh 19, Pa.

CIRCLE 412 ON READER-SERVICE CARD

OPERATIONS RECORDER. 8-page Bulletin 113 illustrates and describes with operational characteristics and specs solid-state Panastat THOR VII transistorized high speed sequential recording annunciator.—Panellit Div. Information Systems, Inc., Skokie, Ill.

CIRCLE 413 ON READER-SERVICE CARD

TRANSISTORIZED ANNUNCIATORS. 12-page Bulletin 200 describes Model AN-100 annunciator series.—Rochester Instrument Systems, Inc., 271 N. Union St., Rochester, N. Y.

CIRCLE 414 ON READER-SERVICE CARD

COLOR ANNUNCIATOR. 8-page Specification Bulletin describes Colorlarm System using the three-color concept.—Ronan Products Co., Van Nuys, Calif.

CIRCLE 415 ON READER-SERVICE CARD

NUCLEONICS

LOW VOLTAGE GEIGER TUBES. 4-page folder describes line of low voltage Geiger tubes and gives tabular data on 12 different tube types.—United States Radium Corp., Morristown, N. J.

CIRCLE 416 ON READER-SERVICE CARD

SCIENTIFIC INSTRUMENTS. 16-page Catalog S/I-1-61 covers line of scientific instruments and systems for electronics, missile and nuclear aplications.—Physical Sciences Corp., 389 N. Fair Oaks Ave., Pasadena, Calif.

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MISCELLANEOUS

ALARM AND STATUS SYSTEM. 2-page bulletin describes remote alarm and status transmission system for communications facilities of public utilities, pipelines, and railroads.—Teleplex, 893 American St., San Carlos, Calif.

CIRCLE 418 ON READER-SERVICE CARD

FLOW REGULATOR. 2-page leaflet describes and illustrates precision regulators including low-flow type.—Millaflow Corp., Subs. of National Welding Equipment Co., 218 Fremont St., San Francisco 5, Calif.

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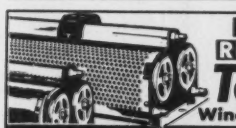

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LINEAR AMPLIFIER. 2-page Bulletin CRL 901 describes Model 901 linear, non-overloading amplifier for nuclear counting applications.—Nuclear Industries, Inc., 10 Holland Court, Valley Stream, N. Y.

CIRCLE 420 ON READER-SERVICE CARD

METAL/CERAMIC INSULATED TC. 8-page folder illustrates and describes metal sheathed ceramic insulated thermocouples, conductors, heating elements, glow plugs, and precision assemblies.—Pyro Electric Co., Inc., Walkerton, Ind.

CIRCLE 421 ON READER-SERVICE CARD

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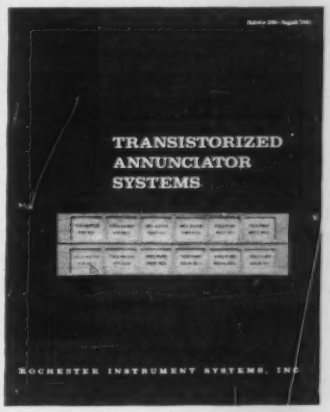

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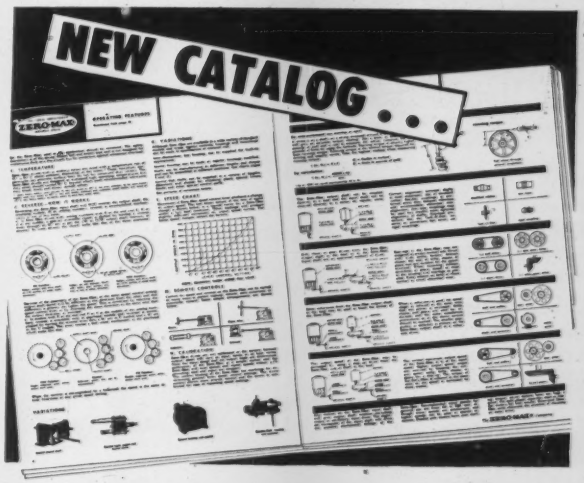

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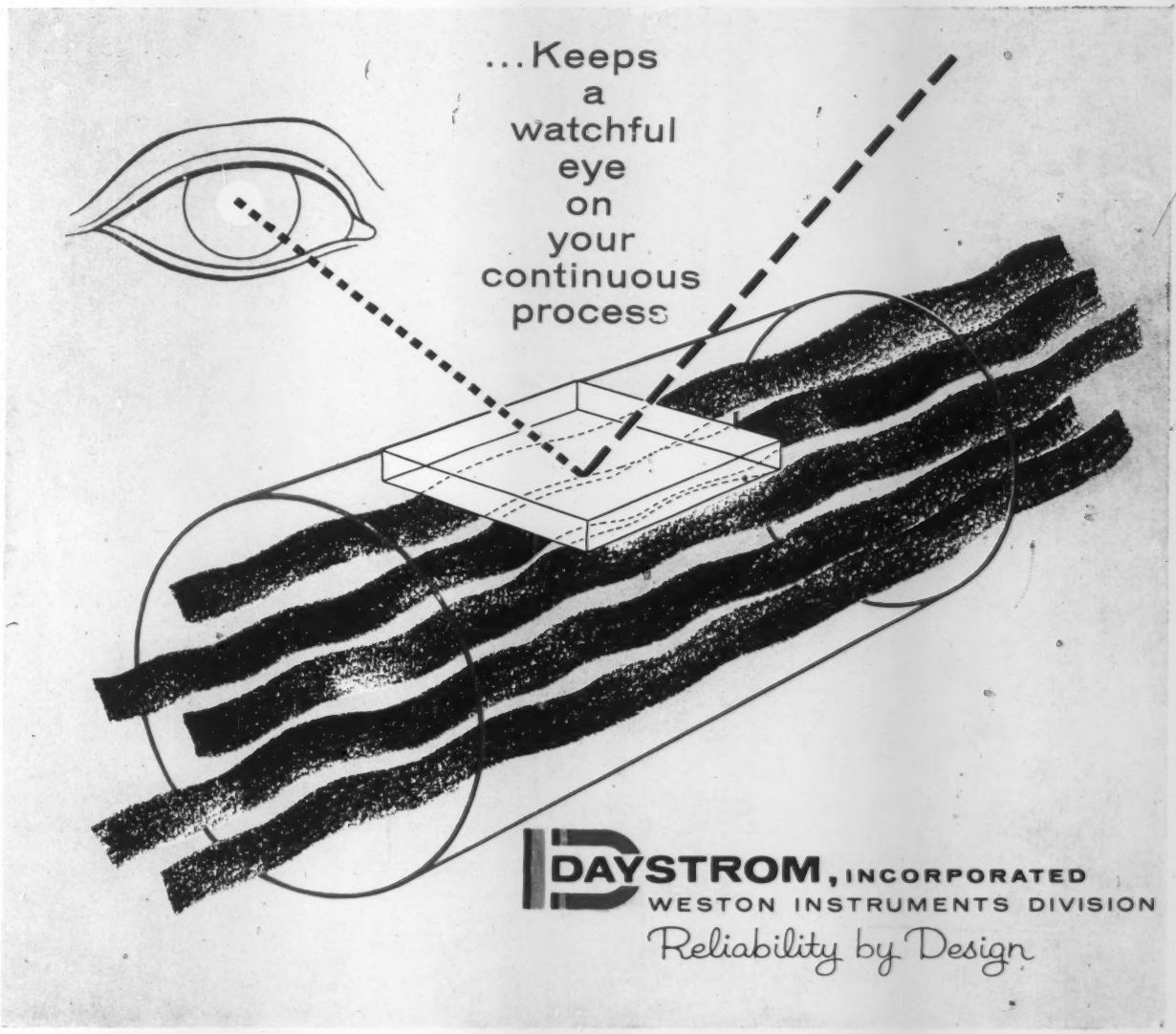

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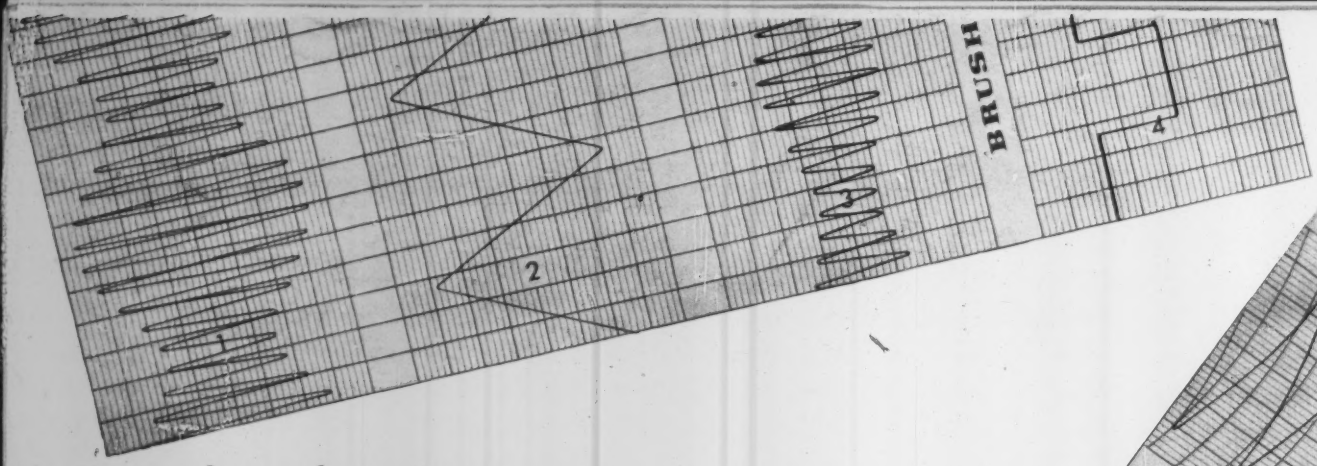

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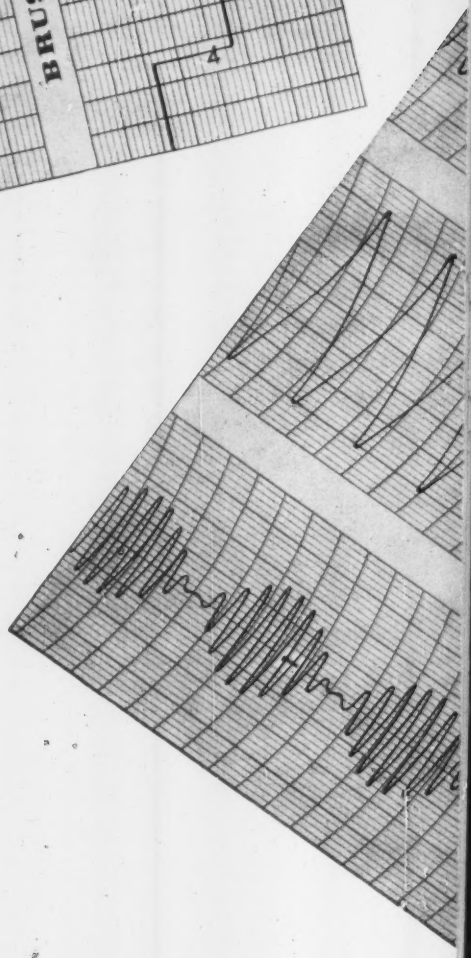

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